1999 Periodic
Carbon Monoxide Emission Inventory

for the

Maricopa County, Arizona Nonattainment Area

November 2001
FINAL Document

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EXECUTIVE SUMMARY

This carbon monoxide (CO) inventory was developed based on requirements in the Clean Air Act Amendments of 1990 (CAAA), passed by Congress and signed into law by the President in November 1990. Title I of the CAAA contains provisions on the required development of carbon monoxide emission inventories for designated areas that failed to meet the National Ambient Air Quality Standards (NAAQS) for carbon monoxide. Maricopa County was designated a CO nonattainment area on November 15, 1990, and was reclassified as serious effective August 28, 1996. Maricopa County Environmental Services Department (MCESD) prepared this 1999 periodic CO emission inventory to meet the requirements of Title I of the CAAA.

This inventory provides calculations of both annual and average season day CO emissions for 1999. The average season day CO emissions mainly cover the period from November 1998 through January 1999. The sources of emissions are categorized in four areas: 1) point sources; 2) area sources; 3) nonroad mobile sources and 4) onroad mobile sources.

A total of 41 individual point sources are identified in this CO inventory. These point sources include a) those sources that emit 50 tons[1] or more per year of CO, b) those sources that were listed as a point source in the 1990, 1993, 1996 CO emission inventories, c) those sources that were listed as point sources in the ozone inventories, both past and present, and have CO emissions greater than 5 tons per year and d) those point sources that are the only source of CO in a category that would otherwise have been considered an area source. Individual stationary point sources account for 0.9 percent of the total average season day CO emissions or 9.09 tons. Stationary point sources contributed an estimated 1753 tons of CO in 1999.

Area sources are those stationary sources in the nonattainment area that are too small to be considered point sources but may be significant in numbers and emit significant amounts of CO. Stationary area sources account for approximately 2.5 percent of the total average season day CO emissions or 24.06 tons per day. Stationary area sources contributed 5,840 tons of CO in 1999.

Nonroad mobile sources include aircraft, locomotives, diesel equipment, 4-stroke gasoline equipment, and 2-stroke gasoline equipment in the nonattainment area. Nonroad mobile sources account for 41.4 percent of the total average season day CO emissions or 404.54 tons daily. Nonroad mobile sources contributed 167,162 tons of CO in 1999.

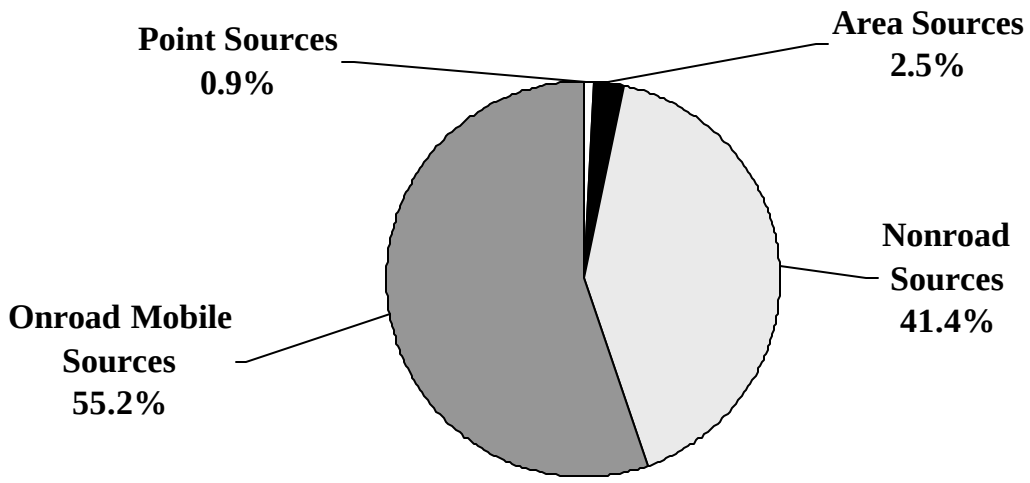
The Maricopa Association of Governments (MAG) calculated onroad mobile source emissions. Emission factors for seven vehicle type categories are calculated using MOBILE5a, the latest in a series of models approved by the EPA for the purposes of estimating motor vehicle emission factors for planning. Onroad mobile sources

[1] As the English system of measurement is used primarily in this document, the term "ton" refers to an English (or short) ton, equal to 2,000 pounds.

accounted for 55.2 percent of the total average season day CO emissions, or 540.41 tons per day. Onroad mobile source annual emissions were not calculated. A chart of this information can be seen with Figure ES–1.

This report is structured to include an overview of the inventory process, tables of summary data, data documentation, and quality assurance steps taken. Each section of the inventory is an independent discussion, which includes an introduction, scope, method and approach for estimating emissions, subsections with example calculations, and summary.

Figure ES-1. Source Category Contributions to Season Day CO Emissions
(Percentage of total season-day CO emissions)



SECTION 1. BACKGROUND AND EMISSIONS SUMMARY

1.1 Background

1.1.1 Type of Inventory, Pollutants, and Source Categories

This carbon monoxide (CO) inventory was developed based on federal requirements stated in the Clean Air Act Amendments of 1990 (CAAA), passed by Congress and signed into law by the President in November 1990. Title I of the CAAA contains provisions on the required development of ozone and carbon monoxide emission inventories for designated areas that failed to meet the National Ambient Air Quality Standards (NAAQS) for ozone and carbon monoxide. The Maricopa County CO nonattainment area was classified as moderate with a design value of 12.6 ppm, and has since been reclassified to serious. Consequently, Maricopa County Environmental Services Department (MCESD) prepared this 1999 periodic CO emissions inventory.

This inventory quantifies both annual and average season day CO emissions from stationary point, area, nonroad mobile, and onroad mobile emission sources for 1999. The season day CO emissions cover the period from November 1998 through January 1999 (MCESD, 2001).

1.1.2 Geographic Area

The Maricopa County CO nonattainment area is approximately 1,962 square miles, or approximately 20 percent of the total Maricopa County land area. The geographic boundaries of the nonattainment area are shown in Figure 1–1.

1.1.3 Demographic Profile

A demographic profile of the Maricopa County CO nonattainment area was provided by the Maricopa Association of Governments (MAG) and is included as Appendix 1–1. This demographic profile was derived from the MAG update of the population and socioeconomic database for Maricopa County (MAG, 2000).

The square miles within the nonattainment area boundary were calculated by digitizing the boundary and summing the area within the boundary using ArcInfo GIS software. There are 1,962 square miles within the CO nonattainment area boundary. Definitions of the terms and a breakdown of population, households, and employment within the nonattainment area boundary are found in Table 1–1.

Figure 1–1. Maricopa County CO Nonattainment Area Boundaries

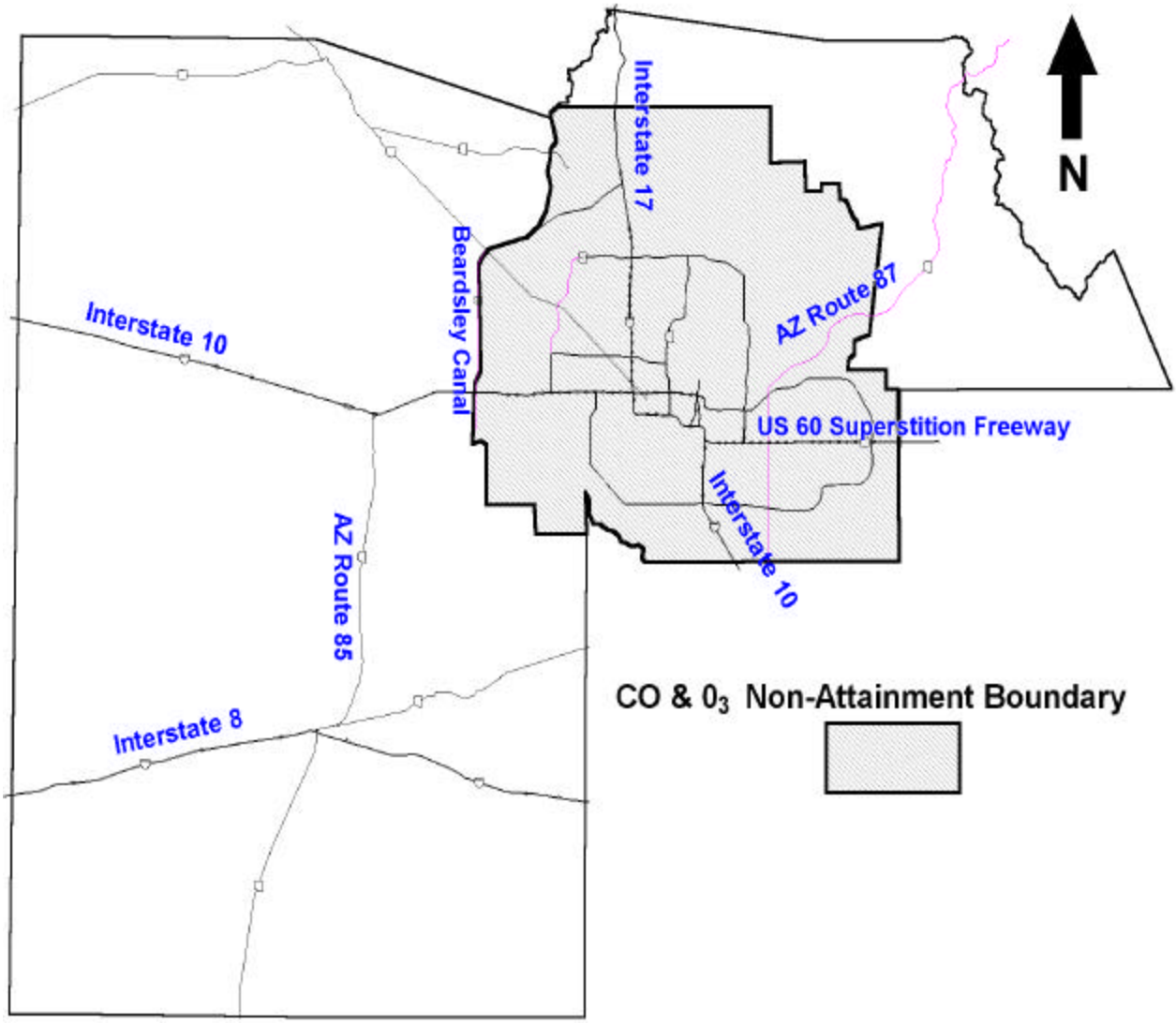


Table 1–1. 1999 Demographic Profile of the CO Nonattainment Area

Parameter	Value
Total Population	2,957,147
Total Households	1,124,469
Total Employment:	1,414,767
– Industrial Employment	313,613
– Office Employment	396,106
– Retail Employment	325,133
– Public Employment	189,263
– Other Employment	190,652

- "Total population" is the sum of resident population in households, resident population in group quarters, transient population, and seasonal population.
- "Total households" is the sum of occupied resident, transient, and seasonal housing units.
- "Industrial employment" includes those jobs in the manufacturing and wholesale trade categories.
- "Office employment" includes finance, consulting, real estate, and insurance. The medical industry is not included.
- "Retail employment" is associated with the retail trade sector of the economy, e.g., department store, grocery store, and restaurant workers.
- "Public employment" includes police, military, museums, schools, government, and libraries.
- "Other employment" is all employment not included in the above categories. Examples include medical, postal, transportation, utilities, and communication.

1.1.4 Agencies and Groups that Prepared and are Responsible for the Inventory

The agency directly responsible for preparing and submitting the Maricopa County nonattainment area 1999 Periodic Carbon Monoxide Emissions Inventory is the Maricopa County Environmental Services Department (MCESD). Carbon monoxide emissions inventories for nonattainment area stationary (point and area) sources and nonroad mobile sources (aircraft and locomotive) were prepared by MCESD. The nonroad equipment source emissions were determined by the EPA in 1990 and were adjusted by MCESD in 1996; the 1996 emissions were then grown to estimate 1999 emissions. The Maricopa Association of Governments (MAG) prepared the onroad mobile source CO emissions inventory. All preparation and quality control contacts are listed in Table 1–2.

Table 1–2. Maricopa County 1999 Periodic CO Emissions Inventory Contacts

Task / Section:	Name and Affiliation	Phone
Emission Inventory Preparation:		
Stationary Point, Area, and Nonroad Mobile Sources	Renee Kongshaug, MCESD	(602) 506-4057
	Bob Downing, MCESD	(602) 506-6790
Transportation Data	Ruey-in Chiou, MAG	(602) 254-6300
Onroad Mobile Sources and Modeling	Roger Roy , MAG	(602) 254-6300
Modeling	Peter Hyde, ADEQ	(602) 207-7642
Quality Assurance / Quality Control:		
Stationary Point, Area, and Nonroad Mobile Sources	Jo Crumbaker, MCESD	(602) 506-6705
Transportation Data/Onroad Mobile Sources and Modeling	Ruey-in Chiou, MAG	(602) 254-6300
External QA	Randy Sedlacek, ADEQ	(602) 207-2300

1.2 Emissions Summary

Average season day CO emissions in the Maricopa County nonattainment area for 1999 are shown in Table 1–3, while annual CO emissions are listed in Table 1–4.

Table 1–3. 1999 Season Daily CO Emissions for the Maricopa County Nonattainment Area

Source Type	Tons CO/ Season Day
Stationary Point Sources	9.09
Area Sources	24.06
Nonroad Mobile Sources	404.54
Onroad Mobile Sources	540.41
Total:	978.10

Table 1–4. Annual 1999 CO Emissions for the Maricopa County Nonattainment Area

Source Type	Tons CO/Year
Stationary Point Sources	1,753
Area Sources	5,840
Nonroad Mobile Sources	167,162
Onroad Mobile Sources	(not calculated)

The remainder of this report is organized as follows: Section 2 addresses the stationary point source categories addressed in this inventory. A list of all point sources and their emissions with sample calculations and summary tables can be seen in section 2. Sample point source reports and calculations can be found in Appendix 2. Section 3 provides a complete explanation of each area source category. Methods of determining emissions and references are also provided. Supporting documentation and calculations can be found in Appendix 3. Section 4 addresses the nonroad mobile sources inventory. Aircraft activity, locomotives, and nonroad equipment are included in this section. Nonroad emissions information, growth factors, and nonroad equipment calculations are shown in Appendix 4. Section 5 describes the estimation of the onroad mobile source inventory, while MOBILE5a computer inputs and descriptions can be found in Appendix 5. Section 6 describes the quality assurance program used to ensure that the inventory is accurate and complete. Copies of completed QA checklists documenting errors found and how these errors were corrected are given in Appendix 6.

1.3 References for Section 1

Maricopa Association of Governments. 1999 Demographic Profile for Maricopa County Ozone and Carbon Monoxide Non-Attainment Areas. July 2000.

Maricopa County Environmental Services Department. 1990 Base Year Carbon Monoxide Emission Inventory. August 1993.

Maricopa County Environmental Services Department. 1993 Periodic Carbon Monoxide Emission Inventory. September 1996.

Maricopa County Environmental Services Department. 1996 Periodic Carbon Monoxide Emission Inventory. December 1998.

US Government Office of the Federal Register, National Archives and Records Administration. Code of Federal Regulations. 40 CFR, Volume 56, 56694. Nov. 6, 1991.

US Government Office of the Federal Register, National Archives and Records Administration. Code of Federal Regulations. 40 CFR, Volume 61, 39343. July 29, 1996.

SECTION 2. INDIVIDUAL STATIONARY POINT SOURCES

2.1 Introduction and Scope

Maricopa County Environmental Services Department (MCESD) is the lead agency responsible for compiling this 1999 periodic CO emissions point source inventory. MCESD is also responsible for identifying all point sources within the nonattainment area, documenting the methods used to calculate emissions from each source, and calculating and presenting the results. For the purposes of this inventory, a point source is defined as a stationary operation that meets one or more of the following criteria:

- It emitted 50 short tons or more of carbon monoxide (CO) in 1999; OR
- It was included as a point source in the 1990, 1993 or 1996 CO periodic emission inventories; OR
- It was included as a point source in the 1990, 1993, or 1996 ozone periodic emission inventories and has measurable CO emissions; OR
- It is the only CO source (or one of a few) in a category that would otherwise have been considered an area source.

This section describes the point source data collection techniques and emission estimation methods, and provides summary tables of annual and season-day point source CO emissions. Table 2–1 shows the point source categories to be addressed in a CO emission inventory (U.S. EPA, 1991), along with those that are present in the non-attainment area and thus included in this inventory.

Table 2–1. Individual Point Source Categories of Carbon Monoxide

External Fuel Combustion:	
Utility Boilers	Included
Industrial Boilers	Included
Commercial/Institutional Boilers	Included
Other External Fuel Combustion	Included
Stationary Internal Combustion:	
Gas Turbines	Included
Reciprocating Engines	Included
Cogeneration	Included
Waste Disposal:	
Municipal Waste Combustion:	
Refuse-Derived Fuel	Included
Mass Burn	Not included, not in area
Coal-fired	Not included, not in area
Other	Not included, not in area

Table 2–1. Individual Point Source Categories of Carbon Monoxide (continued)

Industrial Processes:	
Iron and Steel Manufacturing	
Coke Production	Not included, not in area
Coke Pushing	Not included, not in area
Coke Oven Doors	Not included, not in area
Coke Byproduct Plant	Not included, not in area
Coke Charging, Coal Preheater	Not included, not in area
Topside Leaks, Quenching	Not included, not in area
Battery Stacks	Not included, not in area
Sintering	Not included, not in area
Electric Arc Furnaces	Included
Other Process Units	Included
Petroleum Refineries	Not included, not in area
Mineral Products	
Cement	Not included, not in area
Glass	Not included, not in area
Other	Included
Miscellaneous:	
Aircraft/Rocket Engine Firing and Testing	Included

2.2 Compiling the Point Source List

Applying the criteria for identifying point sources described above resulted in a preliminary list of 223 businesses. After a telephone conversation with Larry Biland of U.S. EPA Region IX, it was agreed to exclude sources that (1) emitted less than 5 English tons of CO in 1999, and (2) were not included in prior years' CO emissions inventories. These smaller sources are considered as part of the area source category. Applying this additional criteria narrowed the point source list to 41 individual sources, listed in Table 2–2.

Detailed process-level emissions information for each point source is collected annually by the Maricopa County Environmental Services Department. Each point source is identified by a Maricopa County business identification (ID) number internal to the County's computerized permit database, as well as business name, and physical address as specified in Table 2–2. (Firms whose names have changed since being reported in earlier inventories are noted in the table.) All point source data will be forwarded to the U.S. Environmental Protection Agency for use in the National Emission Inventory (NEI) database. For questions concerning the identification of point sources and their emissions calculations, contact Bob Downing at *bdowning@mail.maricopa.gov*, or (602) 506-6883.

MCESD identified point sources within the nonattainment area through its Environmental Management System (EMS) permit database. Activity levels were determined from annual emission reports, MCESD source inspection reports, or telephone contacts with sources. Table 2–3 lists the point sources by the categories (determined by process-level Source Classification Codes) within which CO emissions were reported.

Table 2–2. 1999 Annual and Season Daily CO Emissions from All Point Sources

Business ID No.	SIC	Business Name	Address	City	ZIP	Annual CO (tons/yr)	Winter Day CO (lbs/day)	
1075	4952	91st Ave. Wastewater Treatment Plant	5615 S. 91st Ave.	Tolleson	85353	25.28	136.6	
3313	4911	APS West Phoenix Power Plant	4606 W. Hadley St.	Phoenix	85043	101.01	1,202.0	*
961	7996	Big Surf	1500 N. McClintock Dr.	Tempe	85281	1.06	0.0	
1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	2301 W. Durango St.	Phoenix	85009	27.48	125.5	
29919	4953	City of Phoenix 27th Avenue Landfill	2800 S. 27th Ave.	Phoenix	85027	30.76	169.0	
40233	9511	City of Scottsdale / Water Services Division	16800 N. Hayden Rd.	Scottsdale	85261	11.49	63.1	
26	5082	Empire Machinery Co.	1725 S. Country Club Dr.	Mesa	85210	22.14	117.2	
1437	3672	Hadco Phoenix Inc. / Sanmina Phoenix Division	5020 S. 36th St.	Phoenix	85040	8.15	52.2	
3536	2051	Holsum Bakery Inc.	408 S. 23rd Ave.	Phoenix	85009	7.25	55.8	
355	3724	Honeywell International Inc. (formerly *AlliedSignal Engines*)	111 S. 34th St.	Phoenix	85034	31.36	172.3	
354	3341	Imsamet of Arizona	3829 S. Estrella Pkwy.	Goodyear	85338	94.17	496.7	
31617	3674	Intel Corp. Chandler Campus (Fab 6)	5000 W. Chandler Blvd.	Chandler	85226	7.31	59.4	
3966	3674	Intel Corp. Ocotillo Campus (Fab 12)	4500 S. Dobson Rd.	Chandler	85248	6.05	40.3	
3300	9711	Luke Air Force Base	14002 W. Marauder St.	Glendale	85309	14.12	110.0	
744	3325	M.E. West Castings Inc.	5857 S. Kyrene Rd.	Tempe	85283	47.67	359.3	
1254	8062	Maricopa Medical Center	2601 E. Roosevelt St.	Phoenix	85008	1.42	24.2	
1414	1442	Mesa Materials Inc. (Mesa)	3410 N. Higley Rd.	Mesa	85205	15.99	73.8	
1415	1442	Mesa Materials Inc. (Phoenix)	7845 W. Broadway Rd.	Phoenix	85043	11.67	53.9	
881	3674	Motorola Inc.	1300 N. Alma School Rd.	Chandler	85224	7.27	46.7	
1151	3674	Motorola Logic & Analog Tech Group	2200 W. Broadway Rd.	Mesa	85202	16.80	100.6	
223	3524	MTD Southwest Inc.	550 N. 54th St.	Chandler	85226	23.78	183.8	
1878	8661	North Phoenix Baptist Church	5757 N. Central Ave.	Phoenix	85012	1.96	15.1	
52382	4911	Ocotillo Power Plant	1500 E. University Dr.	Tempe	85281	82.79	1,054.1	*
212	3674	ON Semiconductor (formerly *Motorola Inc.*)	5005 E. McDowell Rd.	Phoenix	85008	12.47	87.1	
98	4911	Palo Verde Nuclear Generating Station	5801 S. Wintersburg Rd.	Tonopah	85354	20.96	115.1	
1014	3251	Phoenix Brick Yard	1814 S. 7th Ave.	Phoenix	85007	39.31	216.0	
238	3272	Pre-Cast Manufacturing Co.	301 W. Broadway Rd.	Phoenix	85041	1.42	7.4	
1030	2752	Quebecor World-Phoenix Division	1850 E. Watkins St.	Phoenix	85034	31.97	180.4	
3315	4911	Santan Generating Plant	1005 S. Val Vista Dr.	Gilbert	85296	336.71	3,425.5	*
4175	4226	SFPP LP	49 N. 53rd Ave.	Phoenix	85043	5.51	30.3	
3316	4911	SRP Agua Fria	7302 W. Northern Ave.	Glendale	85303	488.74	6,737.6	*
3317	4911	SRP Kyrene Steam Plant	7005 S. Kyrene Rd.	Tempe	85283	39.03	1,619.5	*
101	2011	Sunland Beef Co.	651 S. 91st Ave.	Tolleson	85353	8.91	51.3	
249	3721	The Boeing Company (formerly *McDonnell Douglas Helicopter Systems*)	5000 E. McDowell Rd.	Phoenix	85215	1.82	14.0	
232	7011	The Phoenician Resort	6000 E. Camelback Rd.	Phoenix	85251	33.06	186.1	
234	2023	United Dairymen of Arizona	2036 S. Hardy Dr.	Tempe	85282	26.79	158.4	
201	1442	United Metro Materials Inc. Plant #1	2875 S. 7th Ave.	Phoenix	85041	55.51	355.8	
260	1442	United Metro Materials Inc. Plant #11	3640 S. 19th Ave.	Phoenix	85009	16.03	64.2	
213	1442	United Metro Materials Inc. Plant #12	11920 W. Glendale Ave.	Glendale	85307	15.02	84.9	
403	3354	VAW of America Inc.	249 S. 51st Ave.	Phoenix	85043	11.88	76.2	
20706	3086	Wincup Holdings Inc.	7980 W. Buckeye Rd.	Phoenix	85048	11.34	57.3	
		TOTAL CO EMISSIONS:				**1,753.46**	**18,178.7**	

* Daily CO emissions from peaking power plants were calculated using data for a peak CO season day.

The following is a list of sources that were included in the 1996 CO point source inventory, but that ceased operations before or during 1999:

Business ID No.	SIC	Business Name	Address	City	ZIP
807	4911	Grove Cogeneration Plant	10853 N. Black Canyon Hwy.	Phoenix	85029
173	3325	Magotteaux-Chandler Inc.	24053 S. Arizona Ave.	Chandler	85248
808	4911	Scottsdale Princess Cogen Plant	7575 E. Princess Dr.	Scottsdale	85255

Pinal County, Arizona was contacted for information about major sources within 25 miles of the metropolitan Phoenix non-attainment area boundaries. No sites in Pinal County met the criteria for inclusion as a point source in this inventory. In addition, the Arizona Department of Environmental Quality was contacted to identify any state-permitted source within the metropolitan Phoenix nonattainment area that should be included as a point source; none were identified.

Table 2–3. Point Source CO Emissions, by Category

Category	Business ID	SIC	Business Name	CO emissions tons/yr	CO emissions lbs/day
EXTERNAL COMBUSTION:					
Utility Boilers:					
	3313	4911	APS West Phoenix Power Plant	0.07	0.0
	52382	4911	Ocotillo Power Plant	61.18	714.7
	98	4911	Palo Verde Nuclear Generating Station	7.04	38.7
	3316	4911	SRP Agua Fria	447.72	4,869.7
	3317	4911	SRP Kyrene Steam Plant	24.17	844.2
Utility Boilers Total:				540.18	6,467.3
Industrial Boilers:					
	26	5082	Empire Machinery Co.	1.45	5.1
	1437	3672	Hadco Phoenix Inc. / Sanmina Phoenix	8.15	52.2
	3536	2051	Holsum Bakery Inc.	7.25	55.8
	355	3724	Honeywell International Inc.	5.97	32.8
	31617	3674	Intel Corp. Chandler Campus (Fab 6)	6.82	44.4
	3966	3674	Intel Corp. Ocotillo Campus (Fab 12)	6.05	40.3
	744	3325	M.E. West Castings Inc.	5.31	34.3
	1415	1442	Mesa Materials Inc. (Mesa)	1.34	6.2
	1414	1442	Mesa Materials Inc. (Phoenix)	1.97	9.1
	881	3674	Motorola Inc.	7.06	38.8
	1151	3674	Motorola Logic & Analog Technical Group	16.55	90.9
	223	3524	MTD Southwest Inc.	0.08	1.4
	212	3674	ON Semiconductor	11.90	65.4
	1014	3251	Phoenix Brick Yard	0.05	0.3
	1030	2752	Quebecor World-Phoenix Division	31.97	180.4
	101	2011	Sunland Beef Co.	8.91	51.4
	249	3721	The Boeing Company	1.56	12.0
	234	2023	United Dairymen of Arizona	26.79	158.4
	201	1442	United Metro Materials Inc. Plant #1	0.43	2.8
	260	1442	United Metro Materials Inc. Plant #11	0.99	6.3
	213	1442	United Metro Materials Inc. Plant #12	0.90	5.3
	403	3354	VAW of America Inc.	9.08	58.2
	20706	3086	Wincup Holdings Inc.	11.34	57.3
Industrial Boilers Total:				171.91	1,009.1

Table 2–3. Point Source Emissions by Category (continued)

Category	Business ID	SIC	Business Name	CO emissions tons/yr	CO emissions lbs/day
EXTERNAL COMBUSTION:					
Commercial/Institutional Boilers:					
	1075	4952	91st Ave. Wastewater Treatment Plant	3.64	33.1
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	0.12	1.3
	3300	9711	Luke Air Force Base	5.06	44.5
	1254	8062	Maricopa Medical Center	0.96	5.3
	1878	8661	North Phoenix Baptist Church	0.06	0.5
	232	7011	The Phoenician Resort	4.06	26.8
Commercial/Institutional Boilers Total:				13.89	111.5
EXTERNAL COMBUSTION TOTAL:				725.98	7,587.9
INTERNAL COMBUSTION:					
Turbines:					
	1075	4952	91st Ave. Wastewater Treatment Plant	0.01	0.1
	3313	4911	APS West Phoenix Power Plant	100.93	1202.0
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	15.39	44.2
	3300	9711	Luke Air Force Base	0.75	4.1
	52382	4911	Ocotillo Power Plant	21.61	339.4
	98	4911	Palo Verde Nuclear Generating Station	0.73	4.0
	3315	4911	Santan Generating Plant	336.71	3,425.5
	3316	4911	SRP Agua Fria	41.01	1,868.3
	3317	4911	SRP Kyrene Steam Plant	14.86	775.6
Turbines Total:				532.01	11,466.3
Reciprocating Engines:					
	1075	4952	91st Ave. Wastewater Treatment Plant	0.02	0.6
	961	7996	Big Surf	1.06	0.0
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	7.70	55.7
	40233	9511	City of Scottsdale / Water Services Div.	11.49	63.1
	26	5082	Empire Machinery Co.	20.68	112.1
	31617	3674	Intel Corp. Chandler Campus (Fab 6)	0.49	15.0
	3300	9711	Luke Air Force Base	0.91	5.0
	1254	8062	Maricopa Medical Center	0.46	19.0
	881	3674	Motorola Inc.	0.20	7.9
	1151	3674	Motorola Logic & Analog Technical Group	0.25	9.7
	1878	8661	North Phoenix Baptist Church	1.90	14.6
	212	3674	ON Semiconductor	0.56	21.7
	98	4911	Palo Verde Nuclear Generating Station	13.18	72.4
	238	3272	Pre-Cast Manufacturing Co.	1.42	7.4
Reciprocating Engines Total:				56.76	384.6
Cogeneration:					
	232	7011	The Phoenician Resort	29.00	159.4
Cogeneration Total:				29.00	159.4
INTERNAL COMBUSTION TOTAL:				617.78	12,010.3

Table 2–3. Point Source Emissions by Category (continued)

Category	Business ID	SIC	Business Name	CO emissions tons/yr	CO emissions lbs/day
WASTE DISPOSAL:					
Refuse-Derived Fuel:					
	1075	4952	91st Ave. Wastewater Treatment Plant	21.61	102.8
	1074	4952	City of Phoenix 23rd Ave. Wastewater Treatment Plant	4.27	24.4
	29919	4953	City of Phoenix 27th Avenue Landfill	30.76	169.0
WASTE DISPOSAL TOTAL:				56.65	296.2
INDUSTRIAL PROCESSES:					
Electric Arc Furnaces:					
	354	3341	Imsamet of Arizona	94.17	496.7
	744	3325	M.E. West Castings Inc.	9.00	69.1
Electric Arc Furnaces Total:				103.17	565.8
Other Process Units:					
	744	3325	M.E. West Castings Inc.	33.36	256.0
	4175	4226	SFPP LP	5.51	30.3
	403	3354	VAW of America Inc.	2.80	18.0
Other Process Units Total:				41.67	304.3
Mineral Processes:					
	1415	1442	Mesa Materials Inc. (Mesa)	10.33	47.7
	1414	1442	Mesa Materials Inc. (Phoenix)	14.02	64.7
	1014	3251	Phoenix Brick Yard	39.26	215.7
	249	3721	The Boeing Company	0.26	2.0
	201	1442	United Metro Materials Inc. Plant #1	55.08	353.1
	260	1442	United Metro Materials Inc. Plant #11	15.04	57.9
	213	1442	United Metro Materials Inc. Plant #12	14.12	79.7
Mineral Processes Total:				148.11	820.8
INDUSTRIAL PROCESSES TOTAL:				292.95	1,690.8
MISCELLANEOUS PROCESSES:					
Aircraft/Rocket Engine Firing and Testing:					
	355	3724	Honeywell International Inc.	25.39	139.5
	3300	9711	Luke Air Force Base	7.41	56.4
	223	3524	MTD Southwest Inc.	23.70	182.3
MISCELLANEOUS PROCESSES TOTAL:				56.50	378.2
TOTAL, ALL PROCESSES:[2]				1753.41	18,180.0

[2] Totals are different from Table 2-2 due to rounding.

2.3 Procedures for Estimating CO Emissions from Point Sources

Emission estimates for the point sources are determined from the annual emission inventory reports submitted by the sources. EPA emission factor documents AP-42 (EPA, 1995 *et seq.*), AIRS 450/4-90-003 (EPA, March 1990), and individual source tests are used to quantify emissions. Appendix 2–1 provides sample 1999 process-level emission inventory reports submitted by a source, while Appendix 2–2 includes a sample of emission factors calculated using site-specific source test results.

Control efficiencies were determined by source tests when available and by AP-42 general factors otherwise however no point sources had CO controls. The CO point sources in Maricopa County are not subject to CO limitations, so no rule effectiveness factors were applied.

MCESD calculated the average season day CO emissions by adjusting the annual emissions to the December, January, and February seasonal output percentages and then dividing them by the operating days per year adjusted for the season. (The time frame is different than the normal winter season, because the emissions are reported in quarters, starting with December 1998–February 1999.) The seasonal percentages and the operating days per year were provided by each source. This calculation was done for all sources except the utilities. The utilities are peaking power plants, which means the units operate on demand so the fuel combustion data for specific days are the best representation of a daily emission estimate. The 1999 peak winter day was requested for worst-case scenario purposes. This data was provided by each facility and the calculation is illustrated in Example 1.

The annual and daily 1999 CO emissions estimates are presented in Table 2–3, which follows the two examples. The two examples were provided to show the method used to calculate average season day CO emissions. Example #1 illustrates the calculation of the actual season day CO emissions for a power plant. Example #2 illustrates the calculation of average season day CO emissions for a non-combustion process from a metal industry facility.

2.3.1 Example 1: Natural Gas-Fired Power Plant

SRP Agua Fria
7302 W. Northern Ave.
Phoenix, AZ

General Facility Information:

Salt River Project (SRP) operates a peaking electric generating plant with three gas/oil-fired boilers and three turbines. The plant is brought on-line when extra generating capacity is needed during periods of peak demand. To provide a reasonable calculation, SRP provided its operating schedule for a peak day in 1999 and 2000 for the CO season day during which the most electricity was generated. On this day, three boilers and three gas turbines operated with an assumed 100% load. The AP-42 emission factors for gas-fired utility boilers are 84 lbs CO/million cubic feet (MMCF) of gas, and 84 lbs CO/million cubic feet of gas for turbines. These factors are

applied to the daily fuel consumption. AP-42 emission factors for diesel-fired equipment are also used to calculate annual CO emissions. Totals for boilers and turbines are added to obtain the total SRP Agua Fria point source CO emissions. SRP Agua Fria provided the following information:

1. Peak Winter Day fuel consumption under 100% load (HFC):
   - Boilers: 57.97 MMCF
   - Gas Turbines: 22.24 MMCF

2. Annual Fuel Consumption:
   - Boilers: 10,659.8 MMCF of natural gas + 4,970 gallons #2 diesel fuel oil
   - Turbines: 713.3 MMCF of natural gas + 260 gallons #2 diesel fuel oil

AP-42 Emission Factors:
- Boilers, natural gas (SCC 10100601) = 84 lbs CO/MMCF
- Boilers, #2 fuel oil (SCC 10100501) = 5 lbs CO/Mgal
- Turbines, natural gas (SCC 20100201) = 84 lbs CO/MMCF
- Turbines, #2 fuel oil (SCC 20100101) = 3.37 lbs CO/Mgal

Annual CO Emissions Calculation:

Natural Gas:

Boilers = 10,659.8 MMCF × 84 lbs/MMCF
= 895,425 lbs/yr

Turbines = 713.3 MMCF × 84 lbs/MMCF
= 59,917 lbs/yr

Total = (895,425 + 59,917) = 955,342 lbs CO/yr
= 477.7 tons CO/yr

#2 Diesel:

Boilers = 4.79 Mgal × 5 lbs/Mgal
= 24 lbs/yr

Turbines = 0.26 Mgal × 3.37 lbs/Mgal
= 0.9 lbs/yr

Total = (24 + 0.9) = 24.9 lbs CO/yr
= 0.01 tons CO/yr

Total Annual Emissions = Natural Gas + Diesel
= 955,342 lbs/yr + 24.9 lbs/yr
= 955,366.9 lbs/yr
= 477.7 tons CO/yr

CO Season Day Emissions Calculation:

Turbine Emissions = 22.24 MMCF × 84 lbs/MMCF
Turbine Emissions = 1,868 lbs/CO day

Boiler Emissions = 57.97 MMCF × 84 lbs/MMCF
Boiler Emissions = 4,869 lbs/CO day

Total CO Season Day Emissions = Total boilers + Total turbines
= 1,868 + 4,869
= 6,737 lb CO/day
= 3.37 tons CO/day

2.3.2 Example 2: Secondary Aluminum Smelting Furnace

Imsamet of Arizona
3829 S. Estrella Pkwy.
Goodyear, AZ

General Facility Information:

This secondary foundry facility has two electric arc furnaces (EAFs) and two heat treat furnaces. Carbon monoxide emissions of 21.5 lbs/hr of operation were calculated from stack tests conducted on the electric arc furnaces in 1992. Production activity from this facility stayed essentially constant throughout the year; thus emissions calculations are based on 8760 hours of operation annually.

Annual CO Emissions Calculation:

Source Emissions = Annual activity level × Emission factor = Total lbs CO/year
= 8760 hr/yr × 21.5 lbs CO/hr
= 188,340 lbs CO/yr
= 94.17 tons CO/yr

CO Season-day Emissions Calculation:

$$\text{Source Emissions} = \frac{\text{Annual activity level} \times \text{Emission factor}}{\text{number of activity days}}$$

$$= \frac{8760 \text{ hr/yr} \times 21.5 \text{ lbs CO/hr}}{365 \text{ days/yr}}$$

= 516 lbs CO/day

= 0.26 tons CO/day

2.4 Emission Reduction Credits

Two facilities that closed out their equipment during 1999 notified Maricopa County to request that their emissions continue to be listed in the emission inventory for possible future use as emission reduction credits. The emission reduction credits for carbon monoxide are as follows:

The Scottsdale Princess Cogeneration – 106 tons of pollutants

Anderson Clayton Oilseed Plant – 5.5 tons of pollutants

Therefore, the total emission reduction credits in 1999 are 111.5 tons.

2.5 References for Section 2

Maricopa County Environmental Services Department (MCESD), 1996. 1993 Base Year Carbon Monoxide Emission Inventory. August 1996.

Maricopa County Environmental Services Department (MCESD), 1999. 1996 Periodic Carbon Monoxide Emission Inventory. September 1999.

U.S. Environmental Protection Agency (US EPA), 1990. AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants. EPA-450/4-90-003. March 1990.

U. S. Environmental Protection Agency, 1991. Emission Inventory Requirements for Carbon Monoxide State Implementation Plans. U.S. EPA/Office of Air Quality Planning and Standards, Rep. EPA 450/4-991-011, March 1991.

U. S. Environmental Protection Agency, 1995. Compilation of Air Pollutant Emission Factors, Vol. I & II. AP-42. 1995 *et seq.*

SECTION 3. AREA SOURCES

3.1 Introduction and Scope

The EPA Emission Inventory Improvement Program produced a table (EPA, August 1999) of area source categories which was evaluated for the CO periodic emissions inventory. Maricopa County regulations prohibit residential incineration and open burning at industrial, commercial/institutional, and residential sources, therefore these categories were excluded. Small-scale combustion sources identified in the EPA procedures document (EPA, May 1991) are not addressed in the inventory because suitable emission factors are not available for estimation purposes, activity data are very difficult and expensive to obtain, and the categories are determined to be negligible contributors to emissions.

3.2 Methodology and Approach

Area source emissions are divided into three categories: fuel combustion, waste disposal, and miscellaneous area sources. The Maricopa County Environmental Services Department (MCESD) prepared the area source emission estimates for all area sources and provided quality assurance. Potential and included area sources can be seen in Table 3–1. EPA emission factor documents are used to quantify emissions.

Table 3–1. CO Area Source Categories

Category / Subcategory	Comment
Stationary Source Fuel Combustion:	
Utility	all are point sources
Industrial	included
Commercial/Institutional	included
Residential	included
Waste Disposal, Treatment and Recovery:	
On-Site Incineration:	included
Industrial	included
Commercial/Institutional	included
Residential	not included, illegal
Open Burning:	permitted only
Industrial	not included, illegal
Commercial/Institutional	not included, illegal
Residential	not included, illegal
Miscellaneous Area Sources:	
Other Combustion:	
Forest Wildfires	included
Charcoal Grilling	not quantified, optional
Structure Fires	included
Fire Fighting Training	included
Fireplaces and Woodstoves	included
Aircraft/Rocket Engine Firing and Testing	all are point sources

One of five emission estimation approaches is used to calculate the area source emissions. Some area source emissions were determined by summing the calculated emissions of individual contributing point sources. Other source categories were calculated based on per capita, commodity consumption-related, or level-of-activity approaches.

3.3 Procedures for Estimating CO Emissions from Stationary Area Source Fuel Combustion

The majority of fuel combustion in Maricopa County is natural gas. Small quantities of fuel oil, including blends and waste are used by some industrial sources. The contribution of liquid petroleum gas (LPG) to total CO emissions is considered insignificant in this area.

Maricopa County Environmental Services Department (MCESD) contacted four natural gas distribution companies to collect natural gas distribution data. Three of the distribution companies are retail distribution companies, while one is wholesale. A list of all four natural gas companies, contacts and distribution data can be seen in Appendix 3–1. The data collected were used to estimate emissions by providing levels of natural gas used by each stationary source in the nonattainment area.

Sales data from the wholesale distributor were obtained as a quality assurance check on the retail data. The wholesale distributor reported supplying the three retail suppliers with approximately 39.2 billion cubic feet of natural gas in 1999. This correlates with the total distribution to consumers reported by the three local retail companies. The small difference found can be explained by two factors: 1) the identification of the nonattainment area by the respective companies was approximate; and 2) other small, non-commercial sources of natural gas are being utilized by the local natural gas retailers (e.g., the City of Mesa buys and sells digester gas from the City of Phoenix 91st Avenue Wastewater Treatment Plant).

Each natural gas distribution company provided their seasonal distribution percentages based on the EPA designated seasons of December–February, March–May, June–August, and September–November. The December–February data are used to estimate total fuel consumption during the CO season and to calculate the emissions. It is assumed that all natural gas sold is ultimately used in a combustion process, although each distribution company does lose a minimal amount to leakage, damaged lines, and venting of lines during repairs.

MCESD requested distribution data showing the types of sources receiving the natural gas from the three retail suppliers. This information allowed all sources to be categorized as either Industrial, Commercial/ Institutional, or Residential. The methods used to calculate the emissions from each source category were identical to those used and presented in the 1990 Base Year CO Emissions Inventory (MCESD, 1993). The 1999 annual and average season day CO emissions are presented in Table 3–4 following the example calculations.

3.3.1 Industrial Area Source Fuel Combustion

3.3.1.1 Natural Gas External Combustion

Table 3–2 provides annual and season daily totals for the industrial fuel combustion category. Total natural gas sales for the industrial user category is 10,016.1 million cubic feet (MMCF). This includes the transport category provided by the retail distributors, which is the amount the distributors "transport" for those industrial sources that buy gas directly from the natural gas wholesaler. From this amount, natural gas used by the point sources listed in Section 1 (4,062.2 MMCF for external combustion and 158.5 MMCF used for internal combustion) was subtracted out to avoid double counting. Therefore, a total of 5,795.4 MMCF was used by industrial area sources.

It was assumed that natural gas for area sources is used for internal and external combustion in the same ratio as for point sources. From the data above: (4,062.2 / [4,062.2 + 158.5]) = 96%. Thus 96%, or 5,563.6 MMCF of natural gas was used in area source external combustion. MCESD chose the combustion rate category of 10–100 $\times$ 10^6 Btu/hr (SCC 10200602) to be representative of industrial area source natural gas external combustion. The CO emission factor for this equipment is 84.0 lb/MMCF (EPA, July 1998). The 1999 CO emissions from industrial area source natural gas external combustion are thus:

5,563.6 MMCF $\times$ 84 lb CO/MMCF = 467,341 lbs/yr = 233.7 tons/yr

3.3.1.2 Natural Gas Internal Combustion

For internal combustion area sources, it was estimated that:

5,795.4 MMCF for all area sources – 5,563.6 MMCF for area source external combustion = 231.8 MMCF of natural gas was used. MCESD chose SCC 20200202 as representative of industrial area source internal combustion, with CO emission factor of 399 lb/MMCF (EPA, July 1998). The 1999 CO emissions from industrial area source natural gas internal combustion are thus:

231.8 MMCF $\times$ 399 lb CO/MMCF = 92,488 lbs/yr = 46.2 tons/yr

Therefore the total annual CO emissions from industrial area source natural gas combustion are as follows:

467,341 lbs + 92,488 lbs = 559,829 lbs or 279.9 tons/yr

The procedure for calculating 1999 season daily CO emissions for industrial external and internal combustion is described below. To determine CO season emissions for industrial area sources, the total amount of natural gas distributed in the December–February period was divided by the total amount of natural gas distributed in 1999:

$$\frac{2{,}604.2 \text{ MMCF}}{10{,}016.1 \text{ MMCF}} \times 100\% = 26\%$$

According to Table 5.8–1 of the EPA procedures document (EPA, May 1991), fossil fuel use for industrial area sources occurs throughout a six-day week. Season daily CO emissions are determined as follows:

$$\text{Season Daily CO emissions (lb/day, external)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/week)} \times \text{Season (weeks/yr)}}$$

$$= \frac{467{,}342 \text{ lb} \times 0.26}{6 \times 13} = 1{,}558 \text{ lb/day} = 0.78 \text{ tons/day}$$

$$\text{Season Daily CO emissions (lb/day, internal)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/week)} \times \text{Season (weeks/yr)}}$$

$$= \frac{92{,}488 \text{ lb} \times 0.26}{6 \times 13} = 308 \text{ lb/day} = 0.15 \text{ tons/day}$$

Therefore the total industrial area source natural gas season daily CO emissions are as follows:

1,558 lbs + 308 lbs = 1,866 lbs or 0.93 tons/day

3.3.1.3 Fuel Oil Internal and External Combustion

It was estimated that 5.45 million gallons of diesel and 2.46 million gallons of fuel oil were burned in boilers, heaters, and engines in Maricopa County in 1999. These total amounts are based on a review of all 1999 emission inventories, with the assumption that an additional 5% was used by those sources that either:

- were operating without a permit,
- were permitted by the state but operating within the non-attainment area (certain portable sources), or
- had a county permit, but were not surveyed in 1999 (some very small sources).

Area source fuel oil use was 164,770 gallons, primarily in boilers and heaters (external combustion); while diesel use was 4,969,020 gallons primarily used in industrial and commercial engines (internal combustion). These totals were calculated by subtracting fuel use reported by point sources listed in Section 1 from the total estimated diesel and fuel oil usage. To calculate CO emissions, the total fuel used is multiplied by the relevant emission factor for industrial equipment burning residual oil or diesel, obtained from AP-42 (EPA, 1998). For the external and internal combustion CO emission factors, MCESD chose industrial external combustion boilers (SCC 10200501) at 5 lbs CO /1000 gallons and reciprocating international combustion engines (SCC 20200102) at 130 lbs CO/1000 gallons, respectively.

Fuel Oil External Combustion:

$$\text{1999 Total CO Emissions} = \text{Total Fuel Used} \times \text{CO Emission Factor}$$
$$= 164{,}770 \text{ gallons} \times 5 \text{ lb/1000 gallons}$$
$$= 824 \text{ lbs or } 0.4 \text{ tons/yr}$$

Diesel Fuel Internal Combustion:

1999 Total CO Emissions = Total Fuel Used × CO Emission Factor
= 4,969,020 gallons × 130 lb/1000 gallons
= 645,973 lbs or 323.0 tons/yr

According to Table 5.8–1 of the EPA Procedures Document (EPA, May 1991), fossil fuel use for industrial area sources is uniform throughout the year, six days per week. Average season daily CO emissions were determined as follows:

Fuel Oil (External):

Season Daily CO Emissions (lb/day) = Annual Emissions (lb) / 6 days/week × 52 weeks/yr

= 824 / 312 = 2.64 lbs/day or 0.001 tons/day

Diesel (Internal):

Season Daily CO Emissions (lb/day) = Annual Emissions (lb) / 6 days/week × 52 weeks/yr

= 645,973 / 312 = 2070 lbs/day or 1.03 tons/day

Table 3–2 is a summary of the area source emissions in the industrial category.

Table 3–2. 1999 CO Emissions from Industrial Area Sources

Fuel Combustion Category	1999 Annual CO Emissions (tons/yr)	1999 Season Day CO Emissions (tons/day)
Natural Gas (External Combustion)	233.7	0.78
Natural Gas (Internal Combustion)	46.2	0.15
Fuel Oil (External and Internal Combustion)	323.4	1.03
Total:	603.3	1.96

3.3.2 Commercial/Institutional Area Source Fuel Combustion

This category of fuel consumption comprises natural gas burned in heating equipment, reciprocating engines, and turbine engines. MCESD assumes that area source natural gas usage for boilers (and similar heating equipment) and for engines is equivalent to the ratio of point source natural gas usage between boilers and engines. The total natural gas usage reported as Commercial/Institutional is 14,202 million cubic feet. Point source fuel use (243.93 MMCF for boilers and 163.19 MMCF for engines) was subtracted from this total to derive a value of 13,795 MMCF used by area sources. The ratio of internal to external combustion for area sources is assumed to be the same as that for point sources (40.1% internal, 59.9% external combustion). Thus:

13,795 MMCF × 40.1% = 5,531.8 MMCF used for internal combustion

13,795 MMCF × 59.9% = 8,263.2 MMCF used in external combustion equipment

3.3.2.1 Natural Gas External Fuel Combustion

A total of 8,263.2 MMCF was estimated to be used in external comb ustion area sources. This total is multiplied by the CO emission factor of 84 lb/MMCF for SCC 201000201 (EPA, July 1998) to determine the annual emissions.

1999 CO Emissions from Commercial/Institutional Heating = 8,263.2 MMCF × 84 lb/MMCF
= 694,109 lbs or 347.1 tons/yr

Calculation of the CO season daily emissions for commercial/institutional heating uses the December-February natural gas distribution figures shown in Table 3-3.

Table 3–3. Suppliers and Total Distribution of Natural Gas to Commercial/Institutional Sources (Area and Point Sources)

	Million Cubic Feet (MMCF)	
Supplier	**Annual**	**Dec.–Feb.**
Southwest Gas Corp. to "Commercial"	12,467.6	3,230.25
City of Mesa to "Commercial"	1,621.0	518.72
Black Mountain Gas Co. to "Commercial"	113.5	34.05
Total:	**14,202.1**	**3,783.02**

The total season consumption is divided by the annual consumption to determine the seasonal adjustment factor for commercial/institutional external combustion as follows:

$$\frac{\text{December-February cubic feet}}{\text{Total cubic feet}} = \frac{3{,}783.02 \text{ MMCF}}{14{,}202.1 \text{ MMCF}} = 0.27$$

According to Table 5.8–1 of the procedures document (EPA, May 1991), fossil fuel in the commercial/institutional category was used throughout a six-day week. Therefore, the season daily CO emissions from heating are calculated as follows:

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{694{,}109 \text{ lbs} \times 0.27}{6 \times 13}$$

= 2,403 lbs/day or 1.20 tons/day

3.3.2.2 Natural Gas Internal Fuel Combustion

Area source commercial/institutional natural gas internal combustion was estimated to be 5,531.8 MMCF in 1999 as explained above. It was assumed that natural gas for area sources is used for internal and external combustion in the same ratio as for point sources. The total natural gas used by reciprocating engine point sources

was 173.51 MMCF, or 54.4% of the total internal combustion engines. Thus, the area source usage of 5,531.8 MMCF was multiplied by 54.4% to get 3,009.3 MMCF of natural gas used by area source reciprocating engines. This was multiplied by the CO emission factor to calculate annual emissions.

Reciprocating engine
emission factor used = 423 lb/MMCF* (EPA, July 2000)

*Average of the four CO emission factors given for 2-stroke and 4-stroke lean burn engines, SCC 20200252 and SCC 20200254.

Total 1999 CO emissions
from reciprocating engines = 3,009.3 MMCF × 423 lb/MMCF
= 1,272,934 lbs or 636.5 tons/yr

Seasonal operations in this category were distributed over a seven-day week and assumed to be constant throughout the year. Therefore the average daily CO season emissions are calculated as follows:

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{1{,}272{,}934 \text{ lbs} \times 0.25}{7 \times 13}$$

= 3,497 lbs/day or 1.75 tons/day

The natural gas used in reciprocating engines was subtracted from total natural gas usage for the category to derive natural usage for turbine engines:

5,531.8 MMCF total – 3,009.3 MMCF in reciprocating engines = 2,522.5 MMCF burned in turbine engines

Turbine engine
emission factor = 84 lb/MMCF (EPA, April 2000).

Total 1999 CO emissions
from turbine engines = 2,522.5 MMCF × 84 lb/MMCF
= 211,890 lbs or 105.9 tons/yr

The seasonal adjustment factor for natural gas combustion in turbine engines is 25%, as determined above for reciprocating engines. Seasonal operations in this category were distributed over a seven-day week. Therefore the season daily CO emissions are calculated as follows:

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{211{,}890 \text{ lbs} \times 0.25}{7 \times 13}$$

= 582.1 lbs/day or 0.30 tons/day

Internal combustion area source CO emissions (both natural gas reciprocating and turbine engines) are shown below:

Total 1999 CO Emissions = 636.5 + 105.9 = 742.4 tons/yr

Season Day CO Emissions = 1.75 + 0.30 = 2.05 tons/day

3.3.3 Residential Area Source Fuel Combustion

Other than wood, the only significant fuel for residential use in Maricopa County is natural gas. Natural gas sales for the residential category of 14,475 million cubic feet (MMCF) were multiplied by an AP-42 CO emission factor of 40 lb/MMCF to determine CO emissions for the year. MCESD applied the CO emission factor for external combustion boilers (residential furnaces; EPA, July 1998). Total 1999 annual residential CO emissions are calculated below:

1999 CO Emissions from
Residential Fuel Combustion = 14,475 MMCF × 40 lb/MMCF
= 579,000 lbs/yr or 289.5 tons/yr

The three natural gas companies provided natural gas distribution according to season. The total natural gas distribution for residential use during the winter season (December to February) was 4,044 MMCF. The seasonal adjustment factor was determined as follows:

$$\frac{\text{December–February}}{\text{Annual Total}} = \frac{4{,}044 \text{ MMCF}}{14{,}475 \text{ MMCF}} = 0.28$$

According to Table 5.8–1 of the procedures document (EPA, May 1991), residential fuel combustion is equally distributed throughout the week, so average daily CO-season emissions are determined as follows:

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{579{,}000 \text{ lbs} \times 0.28}{7 \times 13}$$

= 1,778 lbs/day or 0.89 tons/day

Table 3–4. Summary of CO Emissions from Stationary Area Source Fuel Combustion

Stationary Area Source Fuel Combustion Category	1999 Emissions (tons/yr)	CO Season Day (tons/day)
Industrial External Combustion	234.7	0.78
Industrial Internal Combustion	366.4	1.17
Commercial/Institutional External Combustion	347.1	1.20
Commercial/Institutional Internal Combustion	742.4	2.05
Residential External Combustion	289.5	0.89
Total:	**1,980.1**	**6.09**

3.4 Procedures for Estimating CO Emissions from Waste Disposal, Treatment and Recovery

CO emissions from waste disposal, treatment, and recovery processes are grouped into two parts: (1) emissions from on-site incineration sources; and (2) emissions from industrial, commercial/institutional, and residential open burning. On-site incineration emissions are addressed below while open burning emissions are included in Section 3.4.2.

3.4.1 On-Site Incineration

This category is separated into three classifications of on-site incineration: industrial, commercial/ institutional, and residential. Industrial incinerators are defined as incinerators used to burn materials from all manufacturing establishments in SIC groups 20–39 and which are not classified as point sources. Industrial and commercial/institutional incinerators are located at crematories and veterinarian facilities. Commercial/institutional incinerators burn refuse and paper products from wholesale and retail trade establishments, service establishments, and medical waste from hospitals and laboratories. Residential incinerators burn refuse and paper products from homes and apartment complexes with less than 20 units.

All incinerators are required to be permitted by Maricopa County Environmental Services Department (MCESD). A total of 29 commercial/institutional incinerators operated in Maricopa County during 1999. There was no home or apartment complex in Maricopa County with less than 20 units that operated an incinerator.

The data used to calculate emissions from incinerators were obtained from 1999 emission reports which were submitted to Maricopa County Environmental Services Department (Appendix 3–2). MCESD requires sources to submit annual reports on emissions from processes and/or materials used at each source. For those sources without 1999 emissions reported, the most recent reported data were used.

Annual carbon monoxide emissions for each source are determined by multiplying the total amount of materials burned by the CO emission factor (EPA, October, 1996). Emission factors for incineration were obtained from AP-42, Chapter 2: Solid Waste Disposal, 2.1 Refuse Combustion (EPA, Oct. 1996). Emissions were determined by summing the total annual tons incinerated, and then using the following calculation:

Annual CO Emissions
from Onsite Incineration = Annual Tons Burned × Emission Factor
= 1,845 tons × 10 lbs/ton
= 18,450 lbs/yr or 9.23 tons/yr

Maricopa County Environmental Services Air Pollution Control Regulations Rule 313 does not require controls for CO; so rule penetration and rule effectiveness are not reflected in the CO emission calculations. Therefore, the total annual CO emissions from incinerators are 9.23 tons/year. Based on the average of the operating schedules shown on each source's emissions report, the seasonal adjustment factor of 0.25 is used in the

formula. An average operating schedule of 5 days a week is used. The calculation below illustrates 1999 CO season daily emissions.

$$\text{Season Daily CO Emissions (lb/day)} = \frac{\text{Annual Emissions (lb)} \times \text{Seasonal Factor}}{\text{Operation (days/wk)} \times \text{Season (weeks/yr)}}$$

$$= \frac{18{,}450 \text{ lbs} \times 0.25}{5 \times 13}$$

$$= 71.0 \text{ lbs/day or } 0.04 \text{ tons/day}$$

3.4.2 Open Burning

This section includes emissions from controlled open burning which are regulated by the Maricopa County Air Pollution Control Rules and Regulations. Permits are used to regulate the type of burning, manner, days and times. MCESD issues permits primarily for purposes of agricultural ditch bank and fence row burning, tumbleweed burning, land clearance, fire hazard/training, pest prevention, and trees (air curtain destructors). Amounts of material burned in 1999 are estimated using the burn permits issued. To determine total CO emissions in this category, calculations are made for each type of burning and then added together. Fire training is included in the following section with structure fires.

CO emission factors are given in pounds of CO per ton of vegetation burned. The EPA fuel loading factors provide an estimate of tons of specific vegetation produced per acre (amount produced is considered the amount burned). Emission factors and fuel loading factors were obtained from AP-42 Table 2.5–5 (EPA, Jan. 1995). An excerpt of the factors used is reprinted in Table 3–5.

Table 3–5. Selected Emission Factors and Fuel Loading Factors for Open Burning of Agricultural Materials

Refuse Category	CO Emission Factor (lb CO/ton)	Fuel Loading Factor (waste production, ton/acre)
Weeds: Unspecified	85	3.2
Tumbleweeds	309	0.1
Orchard Crops: Citrus *	81	1.0
Orchard Crops: Unspecified	52	1.6
Field Crops: Unspecified	117	2.0

* The weight of citrus trees (the fuel-loading factor) is estimated to be 500 lbs/tree (MCESD, Aug. 1993).

A summary of the burn permit data is shown in Table 3–6. The calculation of emissions from the burning of ditch banks and fence rows is included for illustration.

Table 3–6. Burn Permit Data Used to Estimate Material Quantities Burned Within the Nonattainment Area

Type of Burning	Amount of Burning	
	Annual (1999)	CO Season
Ditch Banks and Fence Rows	5,935,448 ft	(not allowed)
Tumbleweeds	2,155 piles	32 piles
Air Curtain Destructors	4,044 trees	1,040 trees
Land Clearance	6397.16 acres	66.12 acres
	59 piles	24 piles
Pest Prevention	55 acres	55 acres

3.4.2.1 Burning of Agricultural Ditch Banks and Fence Rows

According to air quality investigators at MCESD, ditch bank and fence row widths are five to ten feet and four feet respectively. These permits are issued for one year and burning occurs at least twice a year. Since there is no data kept regarding actual width, an average of seven feet was assumed for an equal prevalence of ditch banks and fence rows. It was assumed that the total permitted length was within the nonattainment area, or within 25 miles, so the entire length was used in the calculation.

To calculate the amount of material burned on ditch banks and fence rows, MCESD estimated the area burned and multiplied that by the fuel loading factor (see Table 3–6 above) which relates acres to tons of material. The acres of ditch banks and fence rows burned are estimated as follows:

Lengths specified in permits total = 5,935,448 ft

Acres specified = (5,935,448 ft length × 7 ft width × 2 burns/yr × (1acre / 43,560 ft^2)
= 83,096,272 / 43,560
= 1,907.63 acres

The following formula is used to convert the acres of ditch banks and fence rows burned to tons of unspecified weeds burned:

Total tons burned = 1,907.63 acres × 3.2 tons/acre = 6,104.4 tons/yr

Total 1999 CO from Ditch Bank and Fence Row burning = 6,104.4 tons × 85 lb CO/ton
= 518,874 lb CO = 259.44 tons CO/yr

Since ditch bank and fence row burning is not allowed from November to February each year, the daily emissions during the CO season are zero.

3.4.2.2 Burning of Tumbleweeds

Permittees are required to pile tumbleweeds before burning. Tumbleweed burn permittees specify the amount burned in piles. A pile of tumbleweeds fifteen feet in diameter and five feet high was estimated by the Maricopa County/University of Arizona Cooperative Extension Service to weigh 200 lb (MCESD, 1993). This is the same as the AP-42 fuel-loading factor for 1 acre.

In 1999, it was estimated that 2,155 piles or acres of tumbleweeds were burned in the Maricopa County nonattainment area from burn permit data. Using the AP-42 fuel-loading factor of 0.1 ton/acre for Russian thistle (tumbleweed), the total weight burned is calculated as follows:

2,155 acres × 0.1 tons/acres = 215.5 tons

Emissions are calculated according to the following formula:

Annual Tumbleweed emissions = tons burned × emission factor

Total 1999 CO emissions from tumbleweed = 215.5 tons/yr × 309 lb CO/ton burned

= 66,590 lbs/yr or 33.3 tons/yr

Tumbleweed burn permits are valid for one month. Daily season emissions were determined using the permits issued between December and February. Of the 2,155 acres for which permits were issued in 1999, 32 acres were permitted in the winter. Burning was considered to have occurred evenly during the two issuance months. In the same manner as above, the total weight burned is estimated at (32 acres × 0.1 tons/acres = 3.2 tons burned) and CO season emissions from tumbleweed burning are calculated as follows.

CO season emissions from burning tumbleweeds = tons burned × emission factor

= 3.2 tons × 309 lb CO/ton = 989 lb CO/yr

Burning is normally allowed only on the five weekdays. Season daily emissions were calculated according to the following example:

$$\text{Season Daily Emissions (lb)} = \frac{\text{Seasonal Emissions (lb)}}{\text{season operation days}} = \frac{\text{989 lb CO}}{\text{60 days/CO season}} = 16.48 \text{ lb/day or } 0.01 \text{ tons/day}$$

3.4.2.3 Burning of Trees

The Maricopa County/University of Arizona Extension Service Agricultural Agents (MCESD, 1993) estimated the weight of citrus trees to be 500 lb/tree, assuming trees were mature, partially dried and included trunk, limbs and bulk of roots. In 1999, three burn permits were issued for 4,044 trees. Using the fuel-loading factor provided by the agricultural agents, the total weight burned is calculated as:

500 lb/tree × 4,044 trees / (2000 lb/ton) = 1,011 tons

No CO emission factors are available for air curtain destructor burning of trees. Citrus tree emission factor from AP-42's Open Burning section was used.

CO Emissions from burning trees = tons of wood × emission factor

= 1,011 tons × 81 lb CO/ton = 81,891 lbs/yr or 40.9 tons/yr

Since burn permits for trees are valid for only one month, CO season daily emissions are estimated based on the permits issued during the winter season. Only one permit was issued in 1999 during December, for 1,040 trees. It is assumed the trees were burned in one month.

$$\text{Season daily emissions from burning trees} = \frac{260 \text{ tons} \times 81 \text{ lb CO/ton}}{5 \text{ days/week} \times 4 \text{ weeks/month}}$$

$$= 1053.0 \text{ lb/day or } 0.53 \text{ tons/day}$$

3.4.2.4 Burning for Land Clearance

Land clearance burning is comprised of burning assorted brush, grasses and some tree waste. Tree limbs and trunks larger than 6" in diameter are required to be removed. The natural vegetation of the area is desert, so it was assumed the vegetation burned was equal to "unspecified weeds" for choosing fuel-loading and emission factors. Based on 1999 burn permit information, 6397.16 acres were burned for land clearance, plus 59 piles. Assuming a pile is equivalent to an acre, as with tumbleweed, the total burned is 6,456.16 acres. Using the AP-42 fuel-loading factor of 3.2 tons/acre for "unspecified weeds," the weight burned was calculated in tons.

Tons of "unspecified weeds" burned for land clearance = 6,456.2 acres × 3.2 tons/acre = 20,660 tons

Total 1999 CO emissions from burning for land clearance = tons burned × emission factor
= 20,660 tons × 85 lb CO/ton
= 1,756,075 lb CO/yr or 878.0 tons CO/yr

Land clearance burning permits are valid for one month. Six land clearance burn permit for a total of 90.12 acres were issued during the CO season in 1999. They were issued between December and February, so it was assumed the burns occurred within those 3 months.

Tons of CO from burning for land clearance = tons burned × emission factor

$$= \frac{90.12 \text{ acre} \times 3.2 \text{ tons/acre} \times 85 \text{ lb CO/ton}}{3 \text{ months} \times 5 \text{ days/week} \times 4 \text{ weeks/month}}$$

$$= 408.54 \text{ lb CO/ day or } 0.20 \text{ tons CO/day}$$

3.4.2.5 Pest Prevention

Pest prevention burning is comprised of assorted agricultural crops. One permit for 55 acres was issued in 1999. Since the crop wasn't described, an average fuel-loading factor from "unspecified field crop" and "unspecified orchard crop" of 1.8 tons/acre was used.

55 acres × 1.8 tons/acre = 99 tons

The emission factor used to calculate emissions from pest prevention burning was averaged from the above-mentioned categories. The permit, only valid for one month, was issued during the CO season, so assumed all emissions are in one month.

Total CO emissions from burning for pest prevention = tons burned × emission factor

= 99 tons × 84.5 lb/ton
= 8,365.5 lb/yr = 4.2 tons/yr

1999 CO season daily emissions pest prevention = $\frac{8{,}365.5 \text{ lb CO}}{5 \text{ day/wk} \times 4 \text{ wk/month}}$

= 418.28 lb CO/day or 0.21 tons/day

3.4.2.6 Summary of CO Emissions from Managed Burning

Total CO emissions from open burning are obtained by summing the emissions from each type of burning. The results are shown in Table 3–7.

Table 3–7. Summary of CO Emissions From Managed Burning

Type of Burning	Annual 1999 CO Emissions (tons/yr)	1999 Season Daily CO Emissions (lbs/day)
Ditch banks and fence rows (unspecified weeds)	259.4	0.0
Tumbleweeds	33.3	0.01
Air Curtain Destructors (citrus trees)	40.9	0.53
Land clearance (unspecified weeds)	878.0	0.20
Pest Prevention (unspecified crops)	4.2	0.21
Totals:	1,215.8	0.95

3.5 Procedures for Estimating CO Emissions from Miscellaneous Area Sources – Other Combustion

3.5.1 Calculation of Emissions from Forest Fires

The Arizona State Land Department provided the number of wildfires that occurred in and around Maricopa County in 1999. Thirty-three wildfires occurred, burning a total of 192 acres. EPA CO emission factor, 1570 kg/hectare or 1,397.82 lb/acre is used to calculate the emissions (EPA, 1996). The emission factor includes the fuel-loading factor.

Annual CO emissions = 192 acres × 1,397.82 lb/acre = 268,380 lbs CO/yr

= 134.2 tons CO/yr

Assuming that the fires occurred evenly throughout the year for obtaining CO season day emissions:

CO daily emissions = $\frac{268{,}380 \text{ lbs/yr} \times 0.25}{7 \times 13}$ = 737.3 lbs CO/day or 0.37 tons CO/day

3.5.2 Calculation of Emissions from Fireplaces and Wood Stoves

EPA CO emission factors for burning wood in fireplaces and wood stoves are given for tons of wood burned. To determine CO emissions during 1999 for the Maricopa County nonattainment area, MCESD kept constant the emissions that were estimated for 1996. This was done due to the Maricopa County Wood Burning Ordinance that had been put into place September 30, 1994. Although it was anticipated that the ordinance would create a decrease in emissions, there was no concrete evidence to draw data from. Therefore, it was concluded the most conservative course would be to assume the emissions stayed constant. For clarity, how emissions were calculated in the 1996 emission inventory is described below. A few minor errors were discovered in the 1996 inventory, and they were corrected to reflect more accurate emission estimations below. The method for estimating residential wood consumption described in the procedures document (EPA, May, 1991) was used to estimate CO emissions in this category.

3.5.2.1 Proportion of Residential Units With Wood-Burning Devices

Survey data collected in Maricopa County in 1996 was used to calculate emissions from residential woodburning (MAG, 1997). Of the 1,483 surveys, 461 or 31.1% reported having woodburning devices and 295 or 64% used wood. The survey purpose included gathering data on what types of wood are burned and wood-burning device activity.

Number of Fireplaces:

According to the 1994 demographic data provided by MAG, there were 1,005,529 residential housing units in the Maricopa County nonattainment area. The survey in 1996 indicated that of the residences surveyed, there were 398 reported fireplaces out of 461 woodburning devices, or 86.3% (MAG, 1997). Of that 398, 255 or 64.1% use wood in their fireplaces. The number of residential fireplaces contributing emissions for 1999 is estimated using the following series of calculations:

# of woodburning devices = 1,005,529 houses × 0.311 fraction houses with woodburning devices
= 312,720 woodburning devices

# of fireplaces = 312,720 devices × 0.863 fireplaces
= 269,877

# of active fireplaces = 269,877 fireplaces × 0.641 fraction that burns wood = 172,991

Number of Wood Stoves:

The number of wood stoves was determined similarly. Out of the 461 returned surveys that had woodburning devices, 16, or 3.5%, had woodstoves and 10 (62.5%) used them to burn wood. The number of residential woodstoves is estimated using the following series of calculations:

# of woodburning devices = 1,005,529 × 0.311 fraction houses with woodburning devices
= 312,720 woodburning devices

# of woodstoves = 312,720 devices × 0.035
= 10,945

# of active woodstoves = 10,945 woodstoves × 0.625 fraction that burns wood = 6,841

Number of Barbecue (BBQ) / Firepits:

The number of BBQ/firepits was determined similarly. Out of the 461 returned surveys that had woodburning devices, 47, or 10.2%, had firepits and 30 (63.8%) used them to burn wood. The number of residential firepits is estimated using the following series of calculations:

# of woodburning devices = 1,005,529 houses × 0.311 fraction houses with woodburning devices
= 312,720 woodburning devices

# of firepits = 312,720 devices × 0.102
= 31,897

# of Active Firepits = 31,897 firepits × 0.638 fraction that burns wood = 20,351

3.5.2.2 Density and Types of Wood Burned in Maricopa County

Types of wood burned in Maricopa County were also collected during the 1996 survey. Types of wood and the composite density were calculated and the information is provided in Table 3–8. The weighted average density was calculated as follows:

$$\text{Weighted Average Density} = \frac{(144 \times 42.33) + (105 \times 29.48) + (103 \times 18.8) + (13 \times 31.6) + (2 \times 40)}{367}$$

The composite densities listed for hardwood and softwood are a weighted average of densities listed in Table 3–9.

Table 3–8. Density of Wood Types Used in Wood-burning Devices in Maricopa County

Wood Type	Number of Uses from Survey	Composite Density (lb/ft^3)
Hardwood (Mesquite and Gambel Oak)	141	42.33
Softwood (Junipers and Ponderosa Pine)	105	29.48
Processed Logs	103	18.8
Miscellaneous (broken furniture and scrap; used density of Junipers and Ponderosa Pine)	13	31.6
Pellets	2	40
Weighted Average Density:		**31.66**

The US Forest Service (USFS, 1993) provided MCESD with the following mix of tree species harvested for firewood in Arizona and sold in the Maricopa County area. The mix and composite wood density of the various types of wood burned in Maricopa County are shown in Table 3–9. Composite wood density (CWD) combines the percentage of each type of firewood and its density into a single factor, and is calculated according to the following formula:

$$CWD = Ó\ [\ (\%\ \text{wood species}_i) \times (\text{density}_i)\ ]$$

Table 3–9. Wood Mix and Composite Wood Density (CWD) for Wood Species Used for Firewood

Tree Species	% of Total Wood Burned	Density (lb/ft^3)	Composite Wood Density (lb/ft^3)
Both Junipers (Mean)	60 %	30.2	18.1
Ponderosa Pine	20 %	26.3	5.3
Mesquite	10 %	43.7	4.4
Gambel Oak	5 %	39.6	2.0
Pinon Pine and other misc. species	5 %	31.6	1.6

3.5.2.3 Volume and Quantity of Wood Burned in Maricopa County

The frequency and quantity of wood burned in fireplaces in the Maricopa County nonattainment area was also gathered in the 1996 survey (MAG, 1997). Survey respondents were asked the frequency they use their wood-burning devices and the number of logs burned for each use. Using the mean range of the survey results for an average, there are 11.3 uses per household per year and 3.1 logs are burned per use. The estimated number of cords of wood burned in residential fireplaces in the Maricopa County nonattainment area in 1999 was calculated as:

Quantity of Wood Burned in Fireplaces = 172,991 active fireplaces × 11.3 uses/yr × 3.1 logs/use × 0.17 ft^3/log
= 1,030,179 ft^3/yr

Mass of Wood Burned in Fireplaces = 1,030,179 ft^3 × 31.57 lb/ft^3
= 32,522,751 lbs wood/yr
= 16,261.38 tons wood/yr

Similarly, the amount of wood burned in woodstoves was calculated. Using the mean range of the survey results for an average, there are 12.8 uses per household per year and 2.3 logs are burned per use.

Quantity of Wood Burned in Woodstoves = 6,841 active woodstoves × 12.8 uses/yr × 2.3 logs/use × 0.17 ft^3/log
= 34,237 ft^3

Mass of Wood Burned in Woodstoves = 34,237 ft^3 × 31.57 lb/ft^3
= 1,080,862 lbs wood/yr
= 540.43 tons wood/yr

Additionally, the amount of wood burned in firepits was calculated. Using the mean range of the survey results for an average, there are 7.6 uses per household per year and 2.5 logs are burned per use.

Quantity of Wood Burned in Firepits = 20,351 active firepits × 7.6 uses/yr × 2.5 logs/use × 0.17 ft^3/log
= 65,734 ft^3

Mass of Wood Burned in Firepits = 65,734 ft^3 × 31.57 lb/ft^3
= 2,075,222 lbs wood/yr
= 1,037.61 tons wood/yr

3.5.2.4 Annual CO Emissions from Fireplaces, Woodstoves, and Firepits

The carbon monoxide emission factor for residential fireplaces is 252.6 pounds CO per ton of wood fuel taken from the updated Section 1.9 of AP-42 (EPA, January 1995), dated October of 1996. Since the amount of wood burned in fireplaces is estimated to be 17,877.63 tons annually, the total tons of CO from fireplaces is:

$$\text{Tons of CO from fireplaces} = \frac{16{,}261.38 \text{ tons of wood} \times 252.6 \text{ lb/ton}}{2{,}000 \text{ lb/ton}} = 2{,}053.81 \text{ tons CO/yr}$$

The carbon monoxide emission factor for conventional residential wood stoves was calculated as a weighted average. The weighted average emission factor was based on 80% as conventional, noncatalytic, catalytic, and masonry stoves and 20% as certified and exempt pellet stoves. The percentages were taken from the survey. The following calculation shows how the emission factor was calculated by weighted average using AP-42 emission factors for the various wood stove units (EPA, Oct. 1996).

$$\text{Wood Stoves CO Emission Factor} = 0.8 \times [(230.8 + 140.8 + 104.4 + 149)/4] + 0.2 \times [(39.4 + 52.2)/2)]$$

$$\text{Wood Stoves CO Emission Factor} = 125 + 9.16 = 134.16 \text{ lb/ton}$$

$$\text{Tons of CO from conventional wood stoves} = \frac{540.43 \text{ tons} \times 134.16 \text{ lb/ton}}{2{,}000 \text{ lb/ton}} = 36.25 \text{ tons/yr}$$

For firepits, the emission factor used for fireplaces was used to estimate emissions. It was assumed these two devices generate similar emissions as they both lack controls.

$$\text{Tons of CO from firepits} = \frac{1{,}037.61 \text{ tons of wood} \times 252.6 \text{ lb/ton}}{2{,}000 \text{ lb/ton}} = 131.05 \text{ tons/yr}$$

3.5.2.5 CO Season Daily Emissions from Fireplaces and Wood Stoves

It is assumed that 90 percent of the wood burned in Maricopa County is burned in the months of November through February (121 days). These months represent the holiday season and the coldest months of the year. As mentioned earlier the use of fireplaces and wood stoves is primarily for aesthetic purposes.

Determining the CO season typical daily CO emissions requires that a Seasonal Adjustment Factor (SAF) be calculated. This SAF and daily CO emissions are determined based on Section 5.8 and 5.9 of the Procedures document (EPA, May 1991). Calculations are shown below.

$$\text{SAF} = \frac{\text{Peak CO Season Activity)} \times 12 \text{ months}}{\text{Annual Activity} \times \text{Peak CO Season months}}$$

$$= \frac{90\% \times 12 \text{ months}}{100\% \times 4 \text{ months}}$$

$$= 2.7$$

Fireplace and Woodstove CO Emissions for a Typical CO Season Day

= Fireplace and Woodstove Annual Emissions × (SAF) / Annual Activity

= (2,053.81 tons/yr + 36.25 tons/yr) × 2.7 / [(7 days/week) (52 weeks/yr)]

= 15.50 tons CO/day

CO Season Daily Emissions from Firepits

It is assumed that firepits are used evenly throughout the year therefore the annual emissions are divided by 365. The calculation is as follows:

CO Season Daily Emissions = 131.05 tons / 365 = 0.36 tons/day

3.5.3 Calculation of Emissions from Structure, Motor Vehicle, and Vegetation Fires

This section includes emissions from structure, motor vehicle, and vegetation fires. Data was compiled by a survey to all fire departments in the nonattainment area. A complete list was obtained from the Arizona Department of Emergency Services. The request letter and the survey form that was addressed to the directors of these fire departments are included in Appendix 3–3. The data requested included the number of structural, vehicle, and vegetation fires. All of the data supplied were provided on the surveys sent out to the respective fire departments. Eighteen permits obtained for fire training were included in the number of structure fires. Not all fire departments returned the survey, so data from a previous survey (1996,1994, 1993, or 1990 in that order of preference) was used. It is important to note that these emissions may be overstated because the fire data may only represent a partial burn.

The CO emission factor applied to the structure fires can be seen in Table 3–10 below (EPA, July 1999). Estimates of the material burned are obtained by multiplying the number of structure fires by a fuel-loading factor of 1.15 tons of material per fire (EPA, July 1999).

The automobile fire CO emission factor was developed in California Air Resources Board's Methods For Assessing Area Source Emissions (CARB, 1997). It includes a combination of average car body weight and components, and assumes that 60% of the fires included tires. With the assumption that a car's components weigh 500 lbs, the following emissions were calculated:

CO Emissions (Body of Automobile) = 4901 fires/yr × 2.5 lbs CO/fire = 12,253 lbs CO/yr

CO Emissions (Components) = 500 lbs/avg. car × 4,901 fires/yr × 60%
= 91,894 lbs CO

The emission factor used for vegetation burned is 85 lb CO/ton with an AP-42 fuel loading factor of 3.2 tons/acre for "unspecified weeds" (EPA, 1995). Vegetation burned includes fences, alley, trash, and yard fires of accidental occurrence that the fire department has records on. An average size of the fire is unknown so it was assumed to be equal to a tenth of an acre. The number of fires in the vegetation category was multiplied by 0.1.

No seasonal data are available to estimate a seasonal factor. Fires are assumed to occur equally throughout a seven-day week. Therefore, the total emissions per year are divided by 365 to estimate a typical day in the CO season.

Table 3–10. Total CO Emissions from Structure, Automobile, and Vegetation Fires

Type of Fire	Number of Fires	Fuel Loading Factors	CO Emission Factors	Annual CO Emissions (tons/yr)	Peak CO Season Emissions (tons/day)
Structure	3,769	1.15 tons/structure	60 lb/ton	130.0	0.36
Automobile	4,901	500 lbs (avg. wt of car)	2.5 lbs/car 125 lbs/ton	52.1	0.14
Vegetation	6,967	3.2 tons/acre	85 lb/ton	94.7	0.24
Total	**15,637**	———	———	**276.8**	**0.74**

3.6 Summary of All Area Source Emissions

A summary of emissions contributed by area sources is provided in Table 3–11.

Table 3–11. Summary of All Area Source CO Emissions

Report Section	Area Source Fuel Combustion Category	Annual CO Emissions (tons/yr)	Season Day CO Emissions (tons/day)
Stationary Source Fuel Combustion:			
3.3.1	Industrial External Natural Gas Combustion	233.7	0.78
	Industrial Internal Natural Gas Combustion	46.2	0.15
	Industrial External Fuel Oil Combustion	0.4	0.00
	Industrial Internal Fuel Oil Combustion	323.0	1.03
3.3.2	Commercial/Institutional		
	External Combustion	347.1	1.20
	Internal Combustion	742.4	2.05
3.3.3	Residential; External Combustion	289.5	0.89
Waste Disposal, Treatment And Recovery:			
3.4.1	On-Site Incineration	9.2	0.04
3.4.2	Open Burning	1,215.9	0.95
Miscellaneous – Other Combustion:			
3.5.1	Wildfires	134.2	0.37
3.5.2	Fireplaces, Wood Stoves, and BBQ/Firepits	2,221.1	15.86
3.5.3	Structure, Motor Vehicle, and Vegetation Fires	276.8	0.74
TOTALS		**5,839.5**	**24.06**

3.7 References for Section 3

California Air Resources Board. Emissions Inventory Procedural Manual, Volume III: Methods for Assessing Area Source Emissions. October 1997.

Maricopa Association of Governments. 1994 Regional PM_{10} Emission Inventory for the Maricopa County Nonattainment Area. 1997.

Maricopa Association of Governments. Maricopa County Demographic Information, Ozone and CO Non-Attainment Areas, Year 1999. July, 2000.

Maricopa County Environmental Services Department. 1990 Base Year Carbon Monoxide Emission Inventory. August 1993.

Maricopa County Environmental Services Department. 1996 Carbon Monoxide Periodic Emission Inventory. October 1999.

U.S. Environmental Protection Agency. AIRS Facility Subsystem Source Classification Codes and Emission Factor Listing for Criteria Air Pollutants. EPA-450/4-90-003. March 1990.

U. S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, Vol. I & II, AP-42, 1995.

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U.S. Environmental Protection Agency. Introduction to Area Source Emission Inventory Development, Vol. III, EIIP, August 1996.

U.S. Environmental Protection Agency. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Vol. I. EPA-450/4-91-016. May 1991.

U.S. Environmental Protection Agency. Emission Inventory Requirements for Carbon Monoxide State Implementation Plans. EPA-450/4-91-011. March 1991.

SECTION 4. NONROAD MOBILE SOURCES

4.1 Introduction and Scope

The nonroad mobile source inventory includes emissions from aircraft, locomotives, diesel equipment, 4-stroke gasoline equipment, and 2-stroke gasoline equipment. This inventory does not account for aircraft activity at unpaved airports because the activity is considered insignificant. Coal-burning locomotives are not included because there are none in the nonattainment area. Emissions from snowplows and snowmobiles were not included because the Phoenix area does not receive enough snow. Only recreational marine vessels were included, since there aren't any navigable bodies of water suitable for goods transportation.

Aircraft emissions were calculated using survey information provided by the airports and incorporating these data into the EPA's FAA Aircraft Engine Emissions Database (FAEED). Survey information was also used for calculating locomotive emissions. Emission estimates for diesel equipment, 4-stroke and 2-stroke gasoline equipment sources were developed using the Energy and Environmental Analysis, Inc. study prepared for EPA's Office of Mobile Sources (OMS). Nonroad gasoline equipment includes recreational vehicles, construction equipment, industrial/commercial equipment, lawn and garden equipment, and farm equipment. Nonroad diesel equipment includes construction equipment, industrial/commercial equipment, and farm equipment. These emissions estimates were adjusted to reflect growth and conditions specific to the Phoenix nonattainment area as explained in section 4.4. Nonroad emission calculations include 1999 annual and average daily CO.

4.2 Procedure for Estimating Emissions from Aircraft

Emission factors for estimating aircraft emissions were determined using the FAA Aircraft Engine Emissions Database (FAEED). Airport operations data for 1999 were collected from the airports through surveys sent by mail. All airports except Stellar Aviation responded, therefore 1996 operation numbers were used for Stellar Aviation. Table 4–1 shows those general aviation airports included in this inventory and the number of 1999 operations (defined as a landing or a take-off). An LTO is a landing and a take-off cycle, and is used in FAEED to calculate emissions. Therefore, to obtain LTOs, the number of airport operations is divided by two. The operations data provided by the airports are included in Appendix 4-1.

4.2.1 Emission Factors

The alternative fleet-average method, outlined in Procedures for Emission Inventory Preparation Volume IV: Mobile Sources (EPA, 1992) was used to calculate emissions for all types of aircraft. The emission factors are shown below in Table 4–2. When there was more than one type of engine for a specific aircraft, the engine having maximum CO emissions at idle was used. Emission factors were then back calculated by taking emission estimates from FAEED and dividing by LTO cycles. For this method, the emission factors for all unique engines in a certain aircraft type category were averaged since they were reported together in FAEED.

Table 4–1. General Airports and Operation Data

Airport	1999 Operations	1999 LTOs
Chandler Municipal Airport	221,018	110,509
Stellar Aviation	60,000	30,000
Glendale Municipal Airport	130,055	65,028
Phoenix Goodyear Airport	136,278	68,139
Luke Air Force Base	168,520	84,260
Mesa Falcon Field Airport	263,988	131,994
Deer Valley Airport	290,791	145,396
Scottsdale Airport	230,571	115,286
Phoenix Sky Harbor	557,458	278,729
Williams Gateway Airport	236,278	118,139
Total	**2,294,957**	**1,147,480**

Specific air carrier operations in 1999 and aircraft type information for 1998 from Sky Harbor was used for these emission factors. The air taxi emission factor was determined using aircraft type information in FAEED for long- and medium-range jets and averaging the emission factors. General aviation emission factors were determined using the aircraft type information in FAEED for the five different categories of general aviation: single-engine piston, multi-engine piston, single-engine turboprop, multi-engine turboprop, and helicopters. General military emission estimates were determined as a fleet average using all military aircraft in FAEED except fighter jets. As most of the Luke Air Force Base airport operations are F-16's, those military operation emissions were calculated using FAEED data for F-16's. No emission factors were available for the business jet category, so the air carrier emission factor was used, and these emissions were included under general aviation.

Table 4–2. Aircraft Emission Factors

Aircraft Type (AMS 22-75-050-000)	**Emission Factor (lbs CO/LTO)**
Air Carrier	17.25
Air Taxi	36.32
General Aviation Single-Engine Piston	25.55
General Aviation Single-Engine Turboprop	7.87
General Aviation Multiple-Engine Piston	89.72
General Aviation Multiple-Engine Turboprop	18.92
General Military	83.87
Military F-16s	21.06
Helicopters	5.43

4.2.2 Summary of Aircraft Emissions

The FAEED model was used to generate the emission factors for this inventory. Table 4–3 presents the annual and daily emissions estimated by aircraft type and airport. For calculating general aviation emissions, the percentage of each type of aircraft was estimated from information provided by the airports in the MAG Aviation Air Quality Survey for Airports (MAG, 1994).

Sky Harbor winter activity (October through December) was 26.1% of its total annual activity. Other airport winter activity was calculated according to percentage of fourth quarter activity, which was provided in the surveys. Example calculations follow the table.

Table 4–3. Annual and Season Daily 1999 Aviation Emissions

Airport	Aircraft Type	Annual CO Emissions (tons/yr)	Season Day CO Emissions (lbs/day)
Chandler Municipal Airport	Air Taxi	13.0	73
	General Aviation	1,818.5	10,242
	Military	1.9	11
Deer Valley Airport	General Aviation	2,294.0	13,964
	Military	11.4	70
Glendale Municipal Airport	Air Taxi	10.5	57
	General Aviation	515.0	2,799
Phoenix Goodyear Airport	Air Carrier	4.8	28
	General Aviation	1,076.7	6,156
	Military	2.5	14
Luke Air Force Base	Air Carrier/Taxi	22.6	125
	General Aviation	105.8	587
	Military	799.4	4,432
Mesa Falcon Field Airport	Air Carrier	0.2	1
	Air Taxi	30.1	174
	General Aviation	1,823.6	10,556
	Military	208.2	1,205
Phoenix Sky Harbor	Air Carriers	1,508.2	8,557
	Air Taxi	388.9	2,207
	General Aviation	750.4	4,258
	Military	93.4	530
Scottsdale Airport	Air Taxi	65.6	368
	General Aviation	2,109.6	11,832
	Military	9.6	54
Stellar Aviation	General Aviation	406.4	2,209
Williams Gateway Airport	Air Carriers	4.7	25
	Air Taxi	41.9	223
	General Aviation	2,734.6	14,565
	Military	934.9	4,979
Totals		**17,786.5**	**100,292**

4.2.3 Examples

Example 1: Phoenix Sky Harbor provided operations data for 1999 and aircraft type information from 1998.

Type	1999 Operations
Total Air Carrier	475,627
General Aviation	77,375
Military	4,456

Air taxi and helicopter operations were included with the air carrier operations. The three monthly reports provided by the airport separated out air taxi operations. The average percentage of air taxi operations from these

reports was 19%; therefore there are 90,369 air taxi operations. In addition, 7.5%, or 35,672 of reported total air carrier operations are helicopter operations. Unlike the other airports, the information Phoenix Sky Harbor provided was sufficient to create an air carrier aircraft-specific model using FAEED. Results are shown in Appendix 4–2.

For the general aviation category, aircraft type information from the MAG Aviation Survey conducted in 1994 was used to split the category into business jets, single-engine piston, multi-engine piston, single-engine turboprop, and multi-engine turboprop based on percentage of LTOs of each type of aircraft. Operations for 1999 were then further split as follows:

Type	1999 Operations	1999 LTO Cycles
Air Carrier	349,586	174,793
Air Taxi	90,369	45,184
Helicopters	35,672	17,836
General Aviation:	77,375	38,688
–Business Jet	464	232
–Single-engine Piston	57,412	28,706
–Multi-engine Piston	13,618	6,809
–Single-engine Turboprop	0	0
–Multi-engine Turboprop	5,881	2,941
Military	4,456	2,228

4.2.3.1 Phoenix Sky Harbor Air Carrier

Emissions were calculated using the FAEED model by entering data on LTO cycles by aircraft type using 1999 air carrier operations (minus helicopter) and 1998 aircraft type supplied by Phoenix Sky Harbor (Appendix 4–3). The total air carrier emissions calculated by FAEED was 3,794,209 lb/yr. Dividing 349,586 air carrier operations from 439,955 total operations, is 79.5%. Multiplying the total emissions by 79.5%, 3,016,396 lbs/yr are air carrier emissions. Therefore, 20.5% or 777,813 lbs are air taxi emissions. The season day emissions were calculated by multiplying FAEED output by the 26.1% winter seasonal percentage and dividing by 92 days in the season.

Phoenix Sky Harbor Air Carrier Emissions from FAEED

Pollutant	lbs/yr	tons/yr	lbs/season day
CO	3,016,396	1,508.2	8,557

For other airports with air carrier operations, an average emission factor was calculated based on the Phoenix Sky Harbor total air carrier emissions and dividing by LTO cycles:

3,794,209 lb/yr ÷ 219,981 LTOs[3] = 17.25 lb CO/LTO

4.2.3.2 Phoenix Sky Harbor Air Taxi

Air taxi emission factors were calculated from FAEED by averaging all long- and medium-range jets in the database and then dividing by the number of unique engines. Emission factors are shown in Table 4–2. Emissions

for all airports except Phoenix Sky Harbor were calculated by multiplying air taxi LTO cycles by the emission factors. As discussed above, Sky Harbor taxi and carrier operations were reported together. Therefore, of the total air carrier emissions calculated by FAEED, 20.5% or 777,813 lbs CO/yr, were air taxi emissions. The season daily emissions were calculated by multiplying the annual emissions by the winter seasonal percentage (26.1% for Phoenix Sky Harbor) and dividing by 92 days in the season.

Phoenix Sky Harbor Air Taxi Emissions from FAEED

Pollutant	lbs/yr	tons/yr	lbs/season day
CO	777,813	388.9	2,207

Emissions for General Aviation included helicopters, and used the emission factors derived from FAEED. Military emissions were calculated using the FAEED emission factor for general military and the reported LTOs.

4.3 Procedure for Estimating Emissions from Locomotives

Chapter 6 of EPA's Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources (EPA, 1992), was followed when estimating locomotive emissions. Railroad operations were separated into three categories: 1) Class I line haul; 2) Class II and Class III line haul; and 3) yard operations. No Class II or Class III line haul (locally operated railroads), were operating within the nonattainment area boundaries of Maricopa County in 1999. Carbon monoxide emissions were calculated from Class I line haul and yard operations data and EPA emission factors (EPA, 1992, Tables 6–1 and 6–2). Total locomotive emissions in the inventory area were calculated by summing the emissions for both categories.

Railroads operating within the nonattainment boundaries of the Maricopa County are:

1) Union Pacific Railroad Company (UP)
Ms. Deb Schafer (402) 271-2358
Room 930
1416 Dodge Street
Omaha, NE 68179

2) Burlington Northern & Santa Fe Railway Company (BNSF)
Mr. John Chavez (909) 386-4082
740 E Carnegie Drive
San Bernardino, CA 92408-3571

4.3.1 Line Haul Locomotives (AMS 22-85-002-005)

Class I line haul locomotives carry mainly interstate freight and most of the passenger service. Emissions are calculated by multiplying the amount of fuel consumed by these locomotives in the inventory area by the appropriate emission factors (EPA, 1992, Table 6–1). UP provided 1999 Gross Tons (GT) and a Fuel Consumption

[3] This number is slightly different from the 219,977 LTOs for air carriers and air taxis due to rounding.

Index for all trains scheduled to operate in the nonattainment area of Maricopa County (Appendix 4–4). The following calculations show how the line haul locomotive emissions were derived.

BNSF provided a Fuel Consumption Index (FCI) of 734 GTM/gal. GTM = Gross Ton Miles.

$$\text{1999 Gal. Diesel per Line Segment} = \frac{\text{GT} \times \text{Length of segment (miles)}}{\text{FCI}}$$

$$= \frac{37{,}570{,}000 \text{ GT} \times 49.0 \text{ miles}}{734 \text{ GTM/gallon}} = 2{,}508{,}079 \text{ gallons diesel/yr}$$

1999 BNSF line haul locomotive emissions are:

Emissions lbs/year = (annual fuel consumption) × (emission factor)

CO lbs/year = (2,508,079 gallons) × (0.0626 lbs/gallon)
= 157,006 lbs/year
= 78.5 tons/year

The Union Pacific Railway Company (UP) determined fuel consumption and calculated emissions following the same method as above. Traffic density and fuel consumption index were provided by UP (Appendix 4–4). The 1999 fuel consumption as reported by UP for line haul locomotives in Maricopa County is calculated as follows:

$$\text{1999 Gallons of Diesel per Line Segment:} = \frac{68{,}380{,}000 \text{ GT} \times 413 \text{ miles}}{722 \text{ GTM/gallon}} = 39{,}114{,}875 \text{ gallons diesel/yr}$$

1999 UP line haul locomotive emissions are:

CO lbs/yr = (39,114,875 gallons) × (0.0626 lbs/gallon)
= 2,448,591 lbs/yr
= 1224.3 tons/yr

Season day emissions were obtained by dividing annual totals by 365. Table 4–5 shows the line haul locomotive estimates by company for both the year and season day in 1999.

Table 4–4. Summary of Annual 1999 Emissions from Class I Line Haul Locomotives

Company	CO tons/yr	CO lbs/day
Union Pacific Railroad Company	1,224.3	6,709
Burlington Northern & Santa Fe Railway Company	78.5	430
Totals	1,302.8	7,139

4.3.2 Yard Locomotives (AMS 22-85-002-010)

Emission calculations for yard locomotives are based on the number of yard/switch locomotives in operation during 1999. Yard/switch locomotives are primarily responsible for moving railcars within a particular railway yard. The national average of annual carbon monoxide emissions per yard locomotive (EPA, 1992) is

multiplied by the total number of yard locomotives in operation to calculate emissions in tons per year. UP verified that four yard locomotives operated in 1999. BNSF verified that twelve yard locomotives operated in 1999. Therefore, the total number of yard locomotives in Maricopa County is sixteen. Emission calculations for these sixteen yard locomotives are shown below.

Emissions lbs/year = (# of yard/switch locomotives) × (emission factor lbs/yard locomotive)

$$\text{CO emissions} = 16 \text{ locomotives} \times \frac{7{,}375 \text{ lbs CO}}{\text{locomotive}}$$

= 118,000 lbs/yr
= 59.0 tons/yr

Season day emissions were obtained by dividing the annual total by 365.

4.3.3 Summary of Locomotive Emissions

Total annual and season daily emissions from locomotives in the Maricopa County nonattainment area are shown in Table 4–5.

Table 4–5. Summary of 1999 Annual and Season Daily CO Emissions from Locomotives

Locomotive Type	CO (tons/yr)	CO (lbs/day)
Line haul, Class I	1,302.8	7,139
Line haul, Classes II and III	0	0
Yard operations	59.0	323
Total	1,361.8	7,462

4.4 Gasoline and Diesel Nonroad Equipment

Energy and Environmental Analysis, Inc. (EEA) prepared emission estimates for nonroad diesel equipment, 4-stroke gasoline equipment, and 2-stroke gasoline equipment sources (EEA, 1992) for EPA's Office of Mobile Sources (OMS). This "Inventory A" of nonroad equipment was compiled from commercially available marketing research data and publicly available indices of economic activity. Methods used to calculate these emission estimates are described in the Nonroad Engine and Vehicle Emission Study or NEVES (EPA, 1991). The inventories specific to Maricopa County were developed by EEA as part of the NEVES study. Excerpts were taken from the Nonroad Engine Emission Inventories for the CO and Ozone Nonattainment Boundaries, Phoenix Area (EEA, 1992) and include season day adjustments in addition to emissions for each individual engine type and category.

Maricopa County Environmental Services Department has taken these emission estimates and made the following modifications:

1. subtracted emissions applied to the nonattainment area from sources that do not operate in Maricopa County (snowmobiles and snowblowers);

2. developed an average nonroad engine inventory;
3. adjusted the engine type split for 2-stroke vs. 4-stroke lawn mowers;
4. adjusted NO_x emissions for construction equipment;
5. adjusted VOC emissions for lawn and garden equipment; and
6. adjusted the seasonal activity for all nonroad equipment.

In the NEVES study, two nonroad equipment inventories ("Inventory A" and "Inventory B") were created for serious ozone non-attainment areas. EPA guidance suggested that for planning purposes, the two inventories should be averaged. At the time of the study, Maricopa County was classified as moderate so the EEA study only provided an Inventory A, an inventory created from commercially and publicly available data.

During 1996, the Arizona Department of Environmental Quality contracted a study called the Voluntary Early Ozone Plan or VEOP (ADEQ, 1996). An improvement from the VEOP to the nonroad estimates was to create the "pseudo Inventory B" for the Phoenix area. Therefore, a pseudo Inventory B was developed by taking the EEA Inventory A for Phoenix and multiplying the emissions by the average ratio of Inventory B:Inventory A for three areas: El Paso, San Diego, and the San Joaquin Valley (Appendix 4–6). (Inventory B was created using industry provided data that is not publicly available.) Then the emissions from Inventory A and Inventory B were averaged to yield a new 1990 base year inventory. The following calculations show how the new 1990 base year inventory was developed.

1990 NEVES Pseudo Inventory B = 1990 NEVES Base × Average Ratio B/A

1990 New Base = (1990 NEVES Pseudo Inventory B + 1990 NEVES Inventory A) / 2

The 1996 emissions were calculated by multiplying this average of the two inventories, that represents the new 1990 base year emissions, by factors based on economic growth rates. The 1999 annual and average season day emissions listed in Appendix 4–7 for each source category were then calculated by multiplying the 1996 calculated emissions with appropriate growth factors for the period 1996–1999. These growth factors came from the Economic Growth Analysis System (EGAS), which was developed for the Reasonable Further Progress (RFP) inventory. EGAS, an EPA economic and activity forecast model, provides credible growth factors for developing projected emission inventories. Arizona agricultural statistics were used to develop factors for agricultural equipment. See Appendix 4–8 for growth factors used listed by engine type. The following general equation was used to calculate 1999 emissions:

1999 Emissions = 1996 Emissions × EGAS Growth Factor

For some of the nonroad equipment, further adjustments to the emission estimates were applied based on control measures. For lawn mowing equipment, the growth factor was reduced by 2.4% due to the Phoenix xeriscape ordinance. Oxygenated fuel effects were quantified for gasoline-powered equipment. This was a committed measure of the MAG 1999 Serious Area CO Plan, "Winter Fuel Reformulated Gasoline with 3.5 Percent

Oxygen Content November 1 through March 31" (MAG, 1999). MAG ran EPA's CO COMPLEX model, and ascertained a 4.14% reduction in CO emissions from the nonroad gasoline-powered equipment, which was applied to the emissions.

Reductions to nonroad emissions based on new diesel engine standards were considered, however these new standards did not affect CO emissions in 1999 (EPA, 1998). The benefit assessment for the non-handheld nonroad engine rule stated that the rule had minimal effect on the CO inventory in nonattainment areas (EPA, 1996). Therefore, no effects were quantified in the 1999 CO emissions inventory for these two rules.

Two other adjustments were made from the REOP, the Reanalysis of the Metropolitan Phoenix Voluntary Early Ozone Plan prepared in October 1997 (ADEQ, 1997). One was a 52% reduction of NO_x emissions for construction equipment as the original 1996 base-case inventory had overestimated the NO_x emissions. The second was a 50% increase in VOC emissions for lawn and garden equipment as activities such as running and resting losses weren't incorporated in the original inventory (ADEQ, 1997).

Another adjustment occurred with the 1996 emissions inventory. With respect to lawn mowers, local data collected by ADEQ for use in the REOP showed that the 5% to 95% split between 2-stroke and 4-stroke engines based on the VEOP that was used in the 1996 emissions inventory was inaccurate. In Maricopa County, surveyed residents indicated the split is 15% 2-stroke to 85% 4-stroke (ADEQ, 1997). The 1996 emissions were adjusted to reflect this new split, as the 1996 emissions estimates were the basis for the 1999 emissions.

Seasonal data from NEVES were replaced for all nonroad equipment categories. For agricultural equipment, seasonal percentages were determined using local statistics on crop acreage and tractor activity (Appendix 4–9). The crop acres were obtained from the 1999 Arizona Agricultural Statistics (AASS, 2000). Data on tractor activity for various crops were taken from both the 1993–1994 Arizona Vegetable Crop Budgets (U of A, 1993) and the 1994–1995 Arizona Field Crop Budgets (U of A, 1994) since more recent budgets did not contain the same detailed information. Taking the harvested acres of the principal crops grown in Maricopa County, a weighted seasonal activity average was calculated using monthly tractor activity per acre. This calculation included 271,400 acres of principal crops for which the following equation was used:

$$\%\text{Winter Activitiy} = \frac{\sum \text{crop acreage} \times (\text{no.of tractor passes/acre per season} \times \text{no.tractor passes/acre per year})}{\text{total crop acreage}}$$

For all nonroad equipment other than agricultural equipment, seasonal percentages were taken from monthly activity fractions listed in the California Air Resources Board (CARB) Documentation of Input Factors for the New Off-road Mobile Source Emissions Inventory Model (EEA, 1992). The activity levels are provided in Appendix 4–10. MCESD chose to use these seasonal percentages because they more closely resemble the limited data available for Maricopa County. For example, the CARB seasonal percentage of lawn and garden equipment

activity for the winter season is 19.1%. In comparison, the NEVES study indicates that only 6% of the lawn and garden activity occur in the winter based on an analysis of agricultural activity from areas of the country of quite different climates. The following equation was used to adjust emissions to the new seasonal activity levels.

$$\text{Emissions\_new} = (\text{Emissions\_old} \times 0.191) / 0.06$$

where: Emissions_old = 1990 NEVES emissions estimates using 6% season adjustment

Emissions_new = 1990 NEVES emissions estimates using 19.1% season adjustment.

This seasonal adjustment was applied to all engines in the NEVES lawn and garden category. The emission estimates for nonroad equipment are listed in Tables 4–6.

Table 4–6. Summary of all Nonroad Equipment Emissions Within the Nonattainment Area

Type of Equipment	CO tons/yr	CO tons/day
Diesel	7,891.7	21.79
4-Stroke Gasoline	124,636.8	294.58
2-Stroke Gasoline	15,485.0	34.29
Totals	148,013.5	350.66

4.5 Summary of All Nonroad Mobile Source Emissions

Table 4-7 provides a summary of all nonroad mobile source emissions.

Table 4–7. Summary of all Nonroad Mobile Source Emissions

Type of Equipment	CO tons/yr	CO lbs/day
Aircraft Activity	17,786	100,292
Locomotives	1,362	7,462
Nonroad Equipment	148,014	701,320
Totals	167,162	809,074

4.6 References for Section 4

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SECTION 5. ONROAD MOBILE SOURCES

5.1 Introduction

The Maricopa Association of Governments (MAG) prepared the onroad mobile source emission estimates for the 1999 Periodic Carbon Monoxide Inventory for the Maricopa County Nonattainment Area. This documentation is divided into nine subsections: Introduction, VMT Estimation Procedure, Speed Estimation Procedure, CO Season VMT Factor, Emission Factor Estimation Procedure, Summary of CO Emissions From Onroad Mobile Sources, Quality Assurance Process, References, and Appendices.

Onroad mobile source emission estimates have been calculated for carbon monoxide (CO) for the 1999 Periodic CO Inventory. These onroad mobile source estimates are for the 1872 square-mile CO nonattainment area within Maricopa County. Emission estimates were calculated for the following vehicle types: light duty gas vehicles (LDGV), light duty gas truck of gross vehicle weight under 6000 pounds (LDGT1) or over 6000 pounds (LDGT2), heavy duty gas vehicles (HDGV), light duty diesel vehicles and trucks (LDDV and LDDT), heavy duty diesel vehicles (HDDV), and motorcycles (MC). Emission factors for these vehicle types were calculated using MOBILE5a, the current version in a series of models developed by the U.S. Environmental Protection Agency (EPA) for the purpose of estimating motor vehicle emission factors. The resulting emission factors were multiplied by the estimates of vehicle miles of travel (VMT) to generate emission estimates.

5.2 VMT Estimation Procedure

MAG prepared the 1999 vehicle miles of travel (VMT) estimates for the carbon monoxide nonattainment area. The source of data for these estimates is the revised 1999 Highway Performance Monitoring System (HPMS) data (see Appendix 5-1) submitted to the U.S. Department of Transportation, Federal Highway Administration (FHWA) by the Arizona Department of Transportation (ADOT) in April 2001. ADOT initially submitted 1999 HPMS data to FHWA in August 2000. A revised version, incorporating improved traffic counts on the state highway system, was submitted in April 2001. The contact person for the VMT estimates is Cathy Arthur (602-254-6300).

Each year, MAG coordinates the collection of HPMS data, including the annual average daily traffic (AADT) estimates for HPMS sample sections which are utilized to develop HPMS VMT estimates. ADOT provides the AADT for the state highway system routes including interstates, urban freeways, and principal arterials in Maricopa County. ADOT merges the Maricopa County data with information from other Arizona counties to create the statewide HPMS data set submitted to FHWA each year.

Arizona's HPMS database file contains a number of data elements that describe general roadway characteristics and use for every non-local roadway within the state. All non-local roadways have been divided into section records that are 0.3 to 10 miles in length, in accordance with HPMS criteria. Such roadway segments are called HPMS "universe" section records. HPMS contains additional data elements that provide more detailed operational and performance information on a randomly-selected subset of the file's 10,000+ universe records. These more detailed records containing additional highway attributes are known as "sample panels" or "sample sections." The VMT estimates which ADOT submits to FHWA each year are generated from HPMS universe data for all interstates, urban freeways, and principal arterials. Sample section data are expanded to estimate VMT on all other non-local systems.

VMT on local streets in the urbanized portion of the modeling area is estimated using traffic counts collected on 50 randomly-selected local streets in June-July of 1994. These counts resulted in an AADT of 587 for local roads in the urbanized area. To calculate VMT, this AADT was applied to local road mileage in 1994 obtained from the Maricopa County street centerline coverage. In 1994, an AADT of 150 was assumed for local roads which are inside the PM-10 (particulates of size ten microns or less) nonattainment area, but outside the urbanized area boundary. Since 1994, the AADTs on local streets have been increased annually on the basis of the rate of population growth in Maricopa County; the number of center line miles of local streets is updated annually by the local jurisdictions in Maricopa County. VMT for the CO nonattainment area, based on the revised 1999 HPMS data ADOT submitted to FHWA in April 2001, is summarized by area type and facility type in Table 5-1. Area types are a function of population and employment density as described in Table 5-1. Facility types represent the characterizations of different roadway types such as capacity, design, and purpose (i.e. serving regional or neighborhood traffic).

The revised 1999 HPMS System Length and Daily Vehicle Travel for Individual Urbanized Areas (in Appendix 5-1) was submitted to FHWA by ADOT in April 2001. This table reported a 1999 average daily VMT for the Phoenix urbanized area of 55.072 million. In comparison, the 1999 urbanized area VMT for the CO nonattainment area used in the periodic emissions inventory is 54.521 million. The one percent difference between these estimates is attributable to small sections of the Phoenix urbanized area (i.e. Apache Junction) which are not located in the CO nonattainment area. The HPMS System Length and Daily Travel, Donut Area Data for Individual NAAQS Nonattainment Areas, (in Appendix 5-1), reported a revised 1999 VMT for the "donut" area of 5.174 million. The "donut" area is an HPMS term referring to the area inside the PM-10 nonattainment area, but outside the Phoenix urbanized area boundary. The VMT for the CO nonattainment area is 72 percent of the HPMS "donut" area VMT or 3.725 million. The factors (i.e. 99 percent for the urbanized area and 72 percent for the donut area) used to determine the allocation of HPMS VMT to the CO nonattainment area were derived from the report, Maricopa Association of Governments Highway Performance Monitoring System Update, January 1995. These same factors were also used to derive VMT for the CO tracking area in Chapter Three of the MAG 1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area, June 1999. It is important to note that the 1999 HPMS daily VMT for the CO nonattainment area is within one percent of the 1999 VMT estimated by the

MAG travel demand models for the Serious Area CO Plan. The total 1999 daily VMT for the urbanized and "donut" areas in the CO nonattainment area is 58.247 million, as shown in Table 5-1.

The VMT by facility type in Table 5-1 was derived from the 1999 HPMS data, while the distribution by area type was derived from 1998 traffic counts. These counts were assigned to a 1998 highway network using MAG travel demand models. The output of this assignment was evaluated using Geographic Information Systems (GIS) to obtain VMT by area type and facility type for the Phoenix urbanized and "donut" areas. The area type distributions from the MAG traffic assignment were applied to the 1999 HPMS VMT estimates by facility type for the urbanized and "donut" areas to create Table 5-1.

Although HPMS includes vehicle mix data for urban and rural areas of Arizona, there are insufficient classification stations in the Phoenix urbanized area to justify use of this information in calculating VMT by vehicle class. In addition, the HPMS vehicle class data do not discriminate between gas and diesel vehicles. Therefore, MOBILE5a model defaults, representing the fraction of total VMT for each vehicle class, were applied to VMT estimates for each facility type and area type in Table 5-1.

Table 5–1. 1999 HPMS VMT by Area and Facility Type for the CO/Ozone Nonattainment Area
(Annual Average Daily Traffic)

	AREA TYPE *					
Facility Type	**1**	**2**	**3**	**4**	**5**	**Total**
Interstate/Freeway	1,277,694	8,275,357	5,740,120	2,197,672	686,975	18,177,818
Principal Arterial / Minor Arterial	509,464	9,637,550	10,924,791	5,331,263	2,272,805	28,675,873
Collector	261,621	2,943,882	1,374,465	652,983	823,809	6,056,760
Local	59,642	1,823,506	2,191,031	1,088,309	173,623	5,336,111
Total:	2,108,421	22,680,295	20,230,407	9,270,227	3,957,212	58,246,562

* Area Type = f(DENSITY of a planning district) where:
DENSITY = (Population + 2 × Employment) / Area
For Area Type 1, DENSITY = 20,001+
For Area Type 2, DENSITY = 10,001–20,000
For Area Type 3, DENSITY = 5,001–10,000
For Area Type 4, DENSITY = 1,001–5,000
For Area Type 5, DENSITY = 0–1,000

** Collectors are minor streets that connect a neighborhood to a half-mile or mile arterial.

5.3 Speed Estimation Procedure

MAG prepared the average daily speeds for the 1999 periodic carbon monoxide emissions inventory. The average daily speeds were obtained from an EXPLORA emissions model run for 1999. EXPLORA integrates travel

demand modeling output and FORTRAN-based emissions processing programs into a planning tool that may be applied at the subregional or regional level to examine transportation and related air quality issues.

The peak and off-peak speeds used in the EXPLORA volume to capacity (V/C) versus speed table were derived from the MAG study, 1993 Study of Travel Speed and Delay in the MAG Region, January 1995. The peak and off-peak speeds obtained from this study were coded into the link records for each road or street segment for which speed data were collected. A program called SPDVAL was then run to obtain the peak and off-peak speeds by area type and facility type. Freeways and arterials were the only two facility types with a sufficient sample size to obtain speeds by area type.

These peak and off-peak freeway and arterial speeds were used to revise the EXPLORA V/C versus speed table. Speeds for other minor facility types were derived from the MAG study, 1986 Phoenix Urbanized Area Travel Speed Study, October 1986. MAG plans to conduct a new speed study in FY 2002. It is anticipated that the results of this speed study will be incorporated into the next periodic inventory analysis.

1999 link-based traffic volumes and capacities output by the MAG travel demand model were input to EXPLORA to obtain average daily speeds by area type and facility type. The final speeds used in constructing the 1999 periodic emissions inventory are presented in Table 5-2.

Table 5–2. Average Daily Speeds For the 1999 Periodic Emissions Inventory (in mph)

	AREA TYPE *				
Facility Type	**1**	**2**	**3**	**4**	**5**
Interstate/Freeway	52.1	6.8	57.1	61.3	63.3
Principal Arterial / Minor Arterial	27.0	28.0	30.4	33.8	42.0
Collector	24.0	24.3	25.6	28.1	27.7
Local	15.0	20.0	5.0	25.0	30.0

*Area Type = f(DENSITY of a planning district) where:
DENSITY = (Population + 2 × Employment) / Area
For Area Type 1, DENSITY = 20,001+
For Area Type 2, DENSITY = 10,001–20,000
For Area Type 3, DENSITY = 5,001–10,000
For Area Type 4, DENSITY = 1,001–5,000
For Area Type 5, DENSITY = 0–1,000

5.4 CO Season VMT Factor

The Maricopa Association of Governments (MAG) developed the CO season VMT factor for the carbon monoxide periodic emission inventory. Since the VMT utilized in the periodic emissions inventory is based on annual average daily traffic (AADT), it is necessary to examine the relationship between AADT and monthly traffic variations and correct for any differences.

The carbon monoxide season for the Maricopa County nonattainment area occurs from October through April. The peak CO season reflects the three consecutive months when peak CO concentrations occur. For consistency with the 1996 Base Year Carbon Monoxide Inventory, the three consecutive months selected were November 1999 through January 2000, in accordance with EPA guidance.

The CO season VMT factor was developed from 1993 automated traffic recorder (ATR) data collected at five sites located in the CO nonattainment area. Although there were eight active ATRs, only five collected twelve months of continuous data in 1993. The 1993 traffic count factors for the winter months for each ATR are provided below. These represent the ratio of the average monthly counts to the annual average counts.

Traffic Count Factors by Month

	November	December	January
ATR 24 - Grand Ave @ Glendale Ave	0.99555	0.95513	0.99076
ATR 30 - Indian School @ 47th Dr	0.96552	1.03016	1.00377
ATR 31 - Central Ave @ Montebello	1.02748	1.01715	0.93712
ATR 32 - Lincoln Dr @ 23rd St	1.01324	1.02714	0.97627
ATR 34 - Squaw Peak Pkwy @ Crittendon	1.01396	0.99365	0.95205
Averages:	1.00315	1.00465	0.97199

The average (arithmetic mean) of the monthly factors across all five stations is 0.99326. When this factor is applied, the resultant 1999 average daily VMT by facility type for the CO season is illustrated in Table 5-3. Although shopping trips increase during November and December, the reduction in work and school trips during the holidays more than offset this increase.

Table 5–3. Average Daily VMT During 1999 Carbon Monoxide Season (November 1999–January 2000)

	Area Type *					
Facility Type	**1**	**2**	**3**	**4**	**5**	**Total**
Interstate/Freeway	1,269,082	8,219,581	5,701,432	2,182,860	682,345	18,055,300
Principal Arterial / Minor Arterial	506,030	9,572,593	10,851,158	5,295,330	2,257,486	28,482,598
Collector	259,858	2,924,040	1,365,201	648,582	818,257	6,015,937
Local	59,240	1,811,216	2,176,263	1,080,974	172,453	5,300,146
Total:	2,094,210	22,527,430	20,094,054	9,207,746	3,930,540	57,853,980

* Area Type = f(DENSITY of a planning district) where:
DENSITY = (Population + 2 × Employment) / Area
For Area Type 1, DENSITY = 20,001+
For Area Type 2, DENSITY = 10,001–20,000
For Area Type 3, DENSITY = 5,001–10,000
For Area Type 4, DENSITY = 1,001–5,000
For Area Type 5, DENSITY = 0–1,000

5.5 Emission Factor Estimation Procedure

5.5.1 Emission Factor Model

CO vehicle exhaust emission factors were calculated using MOBILE5a. MOBILE5a is a current version in a series of models developed by EPA for the purpose of estimating motor vehicle emission factors for carbon monoxide. The resulting emission factors were combined with VMT estimates to produce emission estimates for carbon monoxide. The MOBILE5a runs were executed by the Maricopa Association of Governments. The contact person for the MOBILE5a emission estimates is Roger Roy (602-254-6300).

The following three MOBILE5a runs were executed for carbon monoxide for a typical day (24-hour period) during the three-month period of November through January:

1. Enhanced inspection/maintenance (I/M240) program in place with no exemption for current +4 model year vehicles. For the purposes of this analysis, the current +4 model years reflect the current model (2000) and the previous four model years (1996-1999).

2. I/M240 program with exemption for current +4 model year vehicles.

3. No I/M program in place.

The emission factors estimated with these runs were combined to reflect the actual proportions of vehicles subject to the specified levels of inspection. The term "I/M vehicles" denotes vehicles which are required to undergo an emission test and/or inspection under the Arizona Vehicle Inspection/Maintenance Program. It is important to note that participation in the I/M program is required for all vehicles *registered* in the nonattainment area, with the exception of certain model year and vehicle types. However, it is assumed that of the vehicles which are of an age and type subject to an I/M program only 91.7 percent of the vehicles *operating* within the nonattainment area participate in the I/M program. The remaining 8.3 percent do not participate in the program. These percentages reflect the implementation of the control measures “Tougher Registration Enforcement” and “Expansion of Area A Boundaries”, described in the MAG 1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area, MAG, June 1999. In the absence of any additional data, this percentage split is assumed to apply directly to VMT as well. Specifically, the base fraction of vehicles participating in the I/M program in the Serious Area CO Plan (89.6 percent) is increased by 2.0 percent reflecting the full implementation of “Tougher Registration Enforcement” and by 0.1 percent reflecting partial implementation of “Expansion of Area A”.

In order to accurately reflect the state of the I/M program in the modeling area, several MOBILE5a runs were performed and the emission factors from those runs were weighted together. Two MOBILE5a runs which reflected I/M and one which reflected no I/M were performed. The weighting of one I/M and one non-I/M run is

explained in the previous paragraph. The weighting of *two* I/M runs is the result of a limitation to the MOBILE5a model. MOBILE5a does not accurately model a change in the variable "last model year tested" if the change in the "last model year tested" value occurred within the current I/M cycle.

This limitation is relevant because the current +4 model year vehicles were exempted from the I/M program beginning in August 1998. This modeling effort reflects the three-month period of November 1999 through January 2000. During the middle of these three months, December 1999, the exemption of current +4 vehicles from testing had been implemented 16 months earlier in the current 24-month cycle. For this reason, the change had effectively propagated through two-thirds (16 months/24 months) of the I/M240 fleet. The exemption of the recent model years was modeled through a weighting of two MOBILE5a runs, one reflecting the exemption of the current +4 model years (in this case, model years 1996-2000) and one which did not include that exemption.

Refer to Appendix 5-2 for portions of the actual input and output files and a spreadsheet showing the emission factor calculations.

5.5.2 Development of Model Inputs

The inputs to MOBILE5a are grouped into eight categories: Control Section, I/M Descriptive Input, Alternative I/M Credit Files, ATP Descriptive Input, Pressure Test Descriptive Input, Scenario Records, Local Area Parameter, and Oxygenated Fuels Descriptive Record. The input values used in the above described MOBILE5a runs are specified and explained below.

5.5.2.1 Control Section

1. TAMFLG=1 indicates that MOBILE5a default tampering rates were used as recommended in the User's Guide.

2. SPDFLG=1 indicates that user-supplied speeds were applied to all vehicle types. *Refer to item 3 in the Scenario Records section for development of input.*

3. VMFLAG=1 indicates that MOBILE5a default VMT mix (national average) was used; this is due to the difficulty in obtaining accurate mileage accumulation rates by vehicle class. This parameter specifies the fraction of total VMT that is accumulated by each of the eight vehicle classes.

4. MYMFLG=3 indicates that user supplied registration distributions and MOBILE5a annual mileage accumulation rates were used, as recommended by the User's Guide. The vehicle registration distributions incorporated into this analysis are derived from registration data for 1999 provided by the Arizona Department of Transportation.

5. NEWFLG=1 indicates that MOBILE5a default basic exhaust rates were used, as recommended by the User's Guide.

6. IMFLAG=1 and 3 means that one of two flags was set in the three MOBILE5a runs that were executed. Two runs assumed that two I/M programs were in place, and the other run assumed that no I/M program was in place. The emission factors obtained from the runs were then weighted together.

7. ALHFLG=1 indicates that no additional correction factors were input. Correction factors were not required per the User's Guide.

8. ATPFLG=1 or 5 were input to indicate that one run involved no anti-tampering program and no pressure test and two runs included both an anti-tampering program and pressure test.

9. RLFLAG=5 indicates that refueling emissions were zeroed-out. Refueling emissions do not contribute to CO emissions.

10. LOCFLG=1 indicates that a separate Local Area Parameter (LAP) record was entered for each scenario of the MOBILE5a runs. The area type for which emission factors were being calculated was specified within each LAP record.

11. TEMFLG=1 indicates that MOBILE5a internally calculated the temperatures to be used in the correction of emission factors based upon the minimum and maximum daily temperatures provided in the LAP record. This option is recommended by the Users' Guide. Note: The ambient temperature input within each scenario record is overridden by the temperature internally calculated by the model.

12. OUTFMT=6 means outputs were in a spreadsheet format to facilitate subsequent calculations.

13. PRTFLG=2 indicates that calculations were performed for CO emission factors only.

14. IDLFLG=1 indicates that no idle emission factors were calculated. Idle emission factors are not necessary for this inventory.

15. NMHFLG=4; note: this flag is not applicable for carbon monoxide runs.

16. HCFLAG=3; note: this flag is not applicable for carbon monoxide runs.

5.5.2.2 I/M Descriptive Input Record

The I/M240 inputs used for the 1999 periodic inventory are consistent with those used for the projected modeling inventory in the Serious Area CO plan for the 2000 base case (MAG, 1999) with minor adjustments made to the waiver rates and last model year tested.

1. PROGRAM START YEAR=77

2. STRINGENCY LEVEL=28% indicates that 28 percent of pre-1981 model year passenger cars or pre-1984 light duty trucks are expected to fail the initial I/M test in a given testing cycle.

3. FIRST MODEL YEAR=67 or 81 for the basic I/M or I/M240 program.

4. LAST MODEL YEAR=20 or 95

5. WAIVER RATE for PRE-1981 MODEL YEAR VEHICLES=1% indicates that one percent of pre-1981 model year vehicles which fail the initial I/M test will receive a waiver.

6. WAIVER RATE for 1981 and LATER MODEL YEAR VEHICLES=2% indicates that two percent of 1981 and later model year vehicles which fail the initial I/M test will receive a waiver.

7. COMPLIANCE RATE=97% indicates that 97 percent of the vehicles regis tered in the modeling area complete the I/M process to the point of either passing the I/M test or receiving a valid waiver.

8. PROGRAM TYPE=1 for centralized program.

9. INSPECTION FREQUENCY=1 or 2 for annual inspection frequency for the basic I/M or biennial frequency for the I/M240 program.

10. VEHICLE TYPES SUBJECT TO INSPECTIONS= 2222 or 2221 indicates that LDGV, LDGT1, LDGT2, and HDGV are all subject to inspection for the basic I/M program but that HDGVs are exempt from the I/M240 program.

11. TEST TYPE=3 or 4 for a loaded idle basic I/M test or a transient I/M240 test.

12. CUTPOINTS=1 or 2 indicates that MOBILE5a default cutpoints were used for the basic I/M program but that non-default cutpoints were used for the I/M240 test.

13. ALTERNATE I/M CREDITS INPUT BY USER=11 or 22 indicates that MOBILE5a default credits were used for Tech I-II and Tech IV+ vehicles for the basic I/M program but that alternate I/M credits were used for the I/M240 program.

14. USER SUPPLIED CUTPOINTS=2.00 30.0 3.00 indicates the cutpoints in grams per mile chosen for HC, CO, and NOx respectively. These cutpoints are used only for the enhanced I/M240 program.

5.5.2.3 Alternative I/M Credit Files

Since the I/M240 cutpoints in use in the nonattainment area are not a standard set of cutpoints built into the MOBILE5a program, an alternative set of cutpoints was developed by Radian International for use in onroad

modeling. These alternative cutpoint credit files were further adjusted by MAG using the EPA Remote Sensing Utility to account for the implementation of a remote sensing program, which was still in place during the period modeled. A remote sensing program is a form of vehicle emissions inspection which measures instantaneous vehicle emissions during actual driving conditions. The credit files listed below are in ASCII format and contain a very large and nondescript array of numbers used to apply emissions reductions credits.

TECH I-II VEHICLES CREDIT FILE= f:\mobile5a\tech12.1me

TECH IV+ VEHICLES CREDIT FILE= f:\mobile5a\imdata.1me

5.5.2.4 ATP Descriptive Input Record

The anti-tampering program (ATP) inputs are consistent with those used for the base case Serious Area CO SIP inventory for 2000.

1. PROGRAM START YEAR=87 indicates that the ATP program began in 1987.
2. FIRST MODEL YEAR=75 indicates that the ATP program includes vehicles of model year 1975 and later.
3. LAST MODEL YEAR=80 indicates that vehicles of model year 1981+ are exempt from the ATP program because they are subject to the I/M240 program.
4. VEHICLE TYPES SUBJECT TO INSPECTIONS= 2222 indicates that LDGV, LDGT1, LDGT2 and HDGV are all subject to inspection.
5. PROGRAM TYPE=1 for centralized program.
6. INSPECTION FREQUENCY=1 for annual inspection frequency.
7. COMPLIANCE RATE=97%
8. INSPECTIONS PERFORMED=22111222 indicates that the following ATP inspections are performed: air pump system, catalyst, evaporative control system, PCV system, and gas cap tests; and that the EGR system, fuel inlet restrictor, and tailpipe lead deposit tests are not performed.

5.5.2.5 Pressure Test Descriptive Input Record

The pressure test inputs are consistent with those used for the base case Serious Area CO SIP inventory for 2000.

1. PROGRAM START YEAR=96 indicates that the pressure test began in 1996.
2. FIRST MODEL YEAR=81 indicates that the pressure test includes vehicles of model year 1981 and later.

3. LAST MODEL YEAR=20 or 95

4. VEHICLE TYPES SUBJECT TO INSPECTIONS= 2221 indicates that LDGV, LDGT1, and LDGT2 are all subject to inspection. HDGV are exempt from the pressure test.

5. PROGRAM TYPE=1 for centralized program.

6. INSPECTION FREQUENCY=2 for biennial inspection frequency.

7. COMPLIANCE RATE=97%

5.5.2.6 Scenario Records

1. REGION=1 indicates the geographic area modeled was low altitude.

2. CALENDAR YEAR=00; was input because the applicable three-month period for this inventory is November, December, 1999 and January, 2000. To be consistent with the User's Guide, the calendar year 2000 was chosen to model conditions representative of the applicable period.

3. SPEED; a scenario utilizing the speed for each combination of facility and area type was executed (see Table 5-2). Speed values were input for interstates/freeways, principal/minor arterials, collectors, and local roads. These speed values were derived from the 1993 Study of Travel Speed and Delay in the MAG Region.

4. AMBIENT TEMPERATURE= 63.7 degrees Fahrenheit; the ambient temperature was calculated from data provided by MCESD (see Appendix 5-3) in accordance with the temperature guidance and input in each scenario. It is important to note that this temperature is not actually utilized by the model due to TEMFLG=1. Refer to item 11 in the Control Section for additional information.

5. OPERATING MODES=20.6, 27.3, 20.6; the MOBILE5a (FTP) standard operating mode fractions were used as recommended by the User's Guide. These values represent percent cold-start/non-catalyst VMT (PCCN), percent cold-start/catalyst VMT (PCCC), and percent hot-start/catalyst VMT (PCHC) respectively. The other relevant operating mode conditions of stabilized/catalyst VMT, stabilized/non-catalyst VMT, and hot-start/non-catalyst VMT are derived internally by MOBILE5a using PCCN, PCCC, PCHC.

6. MONTH OF EVALUATION=Blank indicates that January was the month being evaluated.

5.5.2.7 Local Area Parameter Record

1. SCENARIO NAME; An area type and facility type were indicated for each scenario (speed).

2. ASTM VOLATILITY CLASS was left blank because the RFGFLG (Item 8 below) was set to indicate no reformulated gasoline. Rather, actual monitored fuel data for the modeling period was input to the model, as described in number eight.

3. MINIMUM and MAXIMUM DAILY TEMPERATURE=45 and 73 degrees Fahrenheit; for consistency, the same daily minimum and maximum temperatures used in preparing the 1990 Base Year CO Inventory were also used for the 1999 periodic inventory. The temperatures were calculated by the Maricopa County Environmental Services Department (MCESD) using EPA-recommended procedures (see Appendix 5-3).

4. "PERIOD 1" RVP= 8.43; to determine these inputs, RVP data were obtained from the Arizona Department of Weights and Measures for the applicable period (see Appendix 5-4).

5. "PERIOD 2" RVP = 8.43; the RVP for period 2 is the same as for period 1, with a start year of 2020. The period 2 RVP is in effect being dummied out because only one calendar year is being modeled.

6. OXYFLG=2 indicates the effects of oxygenated fuels were modeled in order to represent actual conditions that existed in the applicable period.

DSFLAG=2 indicates that locally derived diesel sales fractions were used. The diesel sales fractions immediately follow the Oxygenated Fuels Descriptive Records.

RFGFLG was left blank, indicating that the reformulated gasoline flag was set to indicate no reformulated gasoline. Rather than permitting MOBILE5a to set the local gasoline RVP and oxygenate content to reflect default values for Federal RFG, measured gasoline RVP and oxygenate data, provided by the Arizona Department of Weights and Measures for the appropriate time period, were input to MOBILE5a.

5.5.2.8 Oxygenated Fuels Descriptive Record

1. MTBE BLEND MARKET SHARE= 0%; The MTBE market share fraction for the applicable period was obtained from the Arizona Department of Weights and Measures.

2. ALCOHOL BLEND MARKET SHARE=100%; The ethanol market share fraction for the applicable period was obtained from the Arizona Department of Weights and Measures.

3. AVERAGE OXYGEN CONTENT OF ETHER BLEND FUELS=0.0%; to determine this input, testing data were obtained from the Arizona Department of Weights and Measures for the applicable period (see Appendix 5-4).

4. AVERAGE OXYGEN CONTENT OF ALCOHOL BLEND FUELS=3.4%; to determine this input, testing data were obtained from the Arizona Department of Weights and Measures for the applicable period (see

Appendix 5-4). Note that these data do not reflect the entire CO season, but only the period considered in this modeling effort, November 1999 through January 2000.

5. RVP WAIVER SWITCH=1 indicating a 1 psi exemption was not utilized. This is because actual RVP data was input to the model.

5.5.3 Model Outputs

MOBILE5a was executed with the inputs described above to obtain composite emission factors in grams per mile (g/mi) for exhaust CO. These values were obtained for the eight vehicle classes described in the Introduction for the various speeds as described in item three of the Scenario Records section. The emission factors generated for the 1999 carbon monoxide season are presented in the following section. Representative output runs are contained in Appendix 5-2. These values were subsequently used in developing emission estimates.

5.5.5 Summary of Emission Factors

Refer to Appendix 5-2 for the emission factors developed for CO for each facility and area type.

5.5.6 Emission Estimates

MOBILE5a was used to generate CO emission factors for vehicle class, facility, and area type. Daily VMT for the CO season (Table 5-3) was then multiplied by the VMT mix by vehicle class and the appropriate CO emission factor (Appendix 5-2) to estimate CO emissions on a kilogram per day (kg/day) basis. An example calculation is given below:

700,491 (DVMT)	×	0.634 (VMT Mix)	×	7.609 (CO Emission Factor, in g/mi)	÷	1,000 (grams / kg)	=	3,379 (CO emissions in kg/day)

$$3{,}379 \text{ (CO emissions in kg/day)} \times \frac{1 \text{ lb}}{0.4536 \text{ kg}} = 7{,}449 \text{ (CO emissions in lbs/day)}$$

Table 5-4 shows daily VMT data, associated speed estimates, MOBILE5a emission factors, and the calculated onroad emissions for each vehicle class, facility type, and area type.

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
INTERSTATE, FREEWAY, & EXPRESSWAY	LDGV with VMT mix of 60.5%	1	52.1	4.611	1,269,082	7,800.0	3,538.1
		2	56.8	5.572	8,219,581	61,042.9	27,689.1
		3	57.1	5.732	5,701,432	43,557.3	19,757.6
		4	61.3	7.973	2,182,860	23,197.6	10,522.5
		5	63.3	9.040	682,345	8,221.8	3,729.4
	LDGT1 with VMT mix of 17.6%	1	52.1	6.352	1,269,082	3,130.9	1,420.2
		2	56.8	7.836	8,219,581	25,016.3	11,347.4
		3	57.1	8.084	5,701,432	17,900.7	8,119.8
		4	61.3	11.546	2,182,860	9,789.1	4,440.3
		5	63.3	13.196	682,345	3,497.1	1,586.3
	LDGT2 with VMT mix of 8.6%	1	52.1	7.705	1,269,082	1,855.8	841.8
		2	56.8	9.708	8,219,581	15,143.9	6,869.3
		3	57.1	10.041	5,701,432	10,865.1	4,928.4
		4	61.3	14.714	2,182,860	6,095.4	2,764.9
		5	63.3	16.939	682,345	2,193.6	995.0
	HDGV with VMT mix of 3.8%	1	52.1	11.947	1,269,082	1,271.5	576.7
		2	56.8	13.236	8,219,581	9,123.2	4,138.3
		3	57.1	13.344	5,701,432	6,380.0	2,894.0
		4	61.3	15.279	2,182,860	2,796.9	1,268.7
		5	63.3	16.521	682,345	945.3	428.8
	LDDV with VMT mix of 0.2%	1	52.1	0.751	1,269,082	4.2	1.9
		2	56.8	0.791	8,219,581	28.7	13.0
		3	57.1	0.795	5,701,432	20.0	9.1
		4	61.3	0.863	2,182,860	8.3	3.8
		5	63.3	0.908	682,345	2.7	1.2
	LDDT with VMT mix of 1.4%	1	52.1	0.724	1,269,082	28.4	12.9
		2	56.8	0.763	8,219,581	193.8	87.9
		3	57.1	0.766	5,701,432	134.9	61.2
		4	61.3	0.833	2,182,860	56.2	25.5
		5	63.3	0.876	682,345	18.5	8.4
	HDDV with VMT mix of 7.4%	1	52.1	5.334	1,269,082	1,105.4	501.4
		2	56.8	5.620	8,219,581	7,543.6	3,421.8
		3	57.1	5.646	5,701,432	5,256.8	2,384.5
		4	61.3	6.134	2,182,860	2,186.6	991.8
		5	63.3	6.454	682,345	719.2	326.2
	MC with VMT mix of 0.5%	1	52.1	7.126	1,269,082	99.8	45.3
		2	56.8	10.215	8,219,581	926.4	420.2
		3	57.1	10.730	5,701,432	675.0	306.2
		4	61.3	17.937	2,182,860	432.0	196.0
		5	63.3	21.369	682,345	160.9	73.0

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type (continued)

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
PRINCIPAL ARTERIALS & MINOR ARTERIALS	LDGV with VMT mix of 60.5%	1	27.0	8.768	506,030	5,914.2	2,682.7
		2	28.0	8.426	9,572,593	107,511.5	48,767.2
		3	30.4	7.694	10,851,158	111,284.5	50,478.7
		4	33.8	6.836	5,295,330	48,247.2	21,884.9
		5	42.0	5.354	2,257,486	16,111.6	7,308.2
	LDGT1 with VMT mix of 17.6%	1	27.0	11.062	506,030	2,174.2	986.2
		2	28.0	10.668	9,572,593	39,663.0	17,991.2
		3	30.4	9.825	10,851,158	41,406.6	18,782.0
		4	33.8	8.834	5,295,330	18,168.8	8,241.3
		5	42.0	7.156	2,257,486	6,274.8	2,846.2
	LDGT2 with VMT mix of 8.6%	1	27.0	13.358	506,030	1,282.8	581.9
		2	28.0	12.886	9,572,593	23,409.5	10,618.5
		3	30.4	11.875	10,851,158	24,454.8	11,092.7
		4	33.8	10.688	5,295,330	10,740.9	4,872.1
		5	42.0	8.673	2,257,486	3,715.6	1,685.4
	HDGV with VMT mix of 3.8%	1	27.0	15.742	506,030	668.0	303.0
		2	28.0	15.163	9,572,593	12,172.0	5,521.2
		3	30.4	13.983	10,851,158	12,724.0	5,771.6
		4	33.8	12.740	5,295,330	5,657.2	2,566.1
		5	42.0	11.301	2,257,486	2,139.3	970.4
	LDDV with VMT mix of 0.2%	1	27.0	1.122	506,030	2.5	1.1
		2	28.0	1.080	9,572,593	45.6	20.7
		3	30.4	0.994	10,851,158	47.6	21.6
		4	33.8	0.899	5,295,330	21.0	9.5
		5	42.0	0.769	2,257,486	7.7	3.5
	LDDT with VMT mix of 1.4%	1	27.0	1.082	506,030	16.9	7.7
		2	28.0	1.042	9,572,593	308.2	139.8
		3	30.4	0.958	10,851,158	321.2	145.7
		4	33.8	0.867	5,295,330	141.8	64.3
		5	42.0	0.742	2,257,486	51.8	23.5
	HDDV with VMT mix of 7.4%	1	27.0	7.974	506,030	658.9	298.9
		2	28.0	7.677	9,572,593	12,000.9	5,443.6
		3	30.4	7.061	10,851,158	12,512.3	5,675.6
		4	33.8	6.385	5,295,330	5,521.4	2,504.5
		5	42.0	5.463	2,257,486	2,014.0	913.5
	MC with VMT mix of 0.5%	1	27.0	13.083	506,030	73.0	33.1
		2	28.0	12.562	9,572,593	1,326.8	601.9
		3	30.4	11.428	10,851,158	1,368.3	620.7
		4	33.8	10.077	5,295,330	588.8	267.1
		5	42.0	7.931	2,257,486	197.6	89.6

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type (continued)

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
COLLECTOR	LDGV with VMT mix of 60.5%	1	24.0	9.963	259,858	3,450.8	1,565.3
		2	24.3	9.830	2,924,040	38,313.8	17,379.1
		3	25.6	9.292	1,365,201	16,909.0	7,669.9
		4	28.1	8.393	648,582	7,256.0	3,291.3
		5	27.7	8.526	818,257	9,299.0	4,218.0
	LDGT1 with VMT mix of 17.6%	1	24.0	12.427	259,858	1,254.2	568.9
		2	24.3	12.277	2,924,040	13,942.5	6,324.3
		3	25.6	11.662	1,365,201	6,183.4	2,804.8
		4	28.1	10.630	648,582	2,677.9	1,214.7
		5	27.7	10.784	818,257	3,427.2	1,554.6
	LDGT2 with VMT mix of 8.6%	1	24.0	14.997	259,858	739.6	335.5
		2	24.3	14.816	2,924,040	8,221.9	3,729.5
		3	25.6	14.077	1,365,201	3,647.3	1,654.4
		4	28.1	12.840	648,582	1,580.5	716.9
		5	27.7	13.024	818,257	2,022.5	917.4
	HDGV with VMT mix of 3.8%	1	24.0	17.851	259,858	389.0	176.4
		2	24.3	17.612	2,924,040	4,318.6	1,958.9
		3	25.6	16.652	1,365,201	1,906.4	864.8
		4	28.1	15.108	648,582	821.7	372.7
		5	27.7	15.331	818,257	1,052.0	477.2
	LDDV with VMT mix of 0.2%	1	24.0	1.271	259,858	1.5	0.7
		2	24.3	1.255	2,924,040	16.2	7.3
		3	25.6	1.187	1,365,201	7.2	3.2
		4	28.1	1.076	648,582	3.1	1.4
		5	27.7	1.093	818,257	3.9	1.8
	LDDT with VMT mix of 1.4%	1	24.0	1.226	259,858	9.8	4.5
		2	24.3	1.210	2,924,040	109.3	49.6
		3	25.6	1.145	1,365,201	48.3	21.9
		4	28.1	1.038	648,582	20.8	9.4
		5	27.7	1.054	818,257	26.6	12.1
	HDDV with VMT mix of 7.4%	1	24.0	9.034	259,858	383.4	173.9
		2	24.3	8.915	2,924,040	4,256.9	1,930.9
		3	25.6	8.435	1,365,201	1,880.5	853.0
		4	28.1	7.649	648,582	810.1	367.5
		5	27.7	7.763	818,257	1,037.3	470.5
	MC with VMT mix of 0.5%	1	24.0	14.843	259,858	42.6	19.3
		2	24.3	14.651	2,924,040	472.7	214.4
		3	25.6	13.864	1,365,201	208.8	94.7
		4	28.1	12.511	648,582	89.5	40.6
		5	27.7	12.715	818,257	114.8	52.1

Table 5–4. CO Emissions by Vehicle Class, Area Type, and Facility Type (continued)

Facility Type	Vehicle Class	Area Type	Speed (mi/hr)	Emission Factor (grams/mi)	DVMT (miles)	Emissions (lb/day)	Emissions (kg/day)
LOCAL	LDGV with VMT mix of 60.5%	1	15.0	14.486	59,240	1,143.8	518.8
		2	20.0	12.096	1,811,216	29,201.9	13,246.0
		3	25.0	9.534	2,176,263	27,654.5	12,544.1
		4	25.0	9.534	1,080,974	13,736.3	6,230.8
		5	30.0	7.808	172,453	1,794.8	814.1
	LDGT1 with VMT mix of 17.6%	1	15.0	17.669	59,240	406.5	184.4
		2	20.0	14.835	1,811,216	10,435.9	4,733.7
		3	25.0	11.938	2,176,263	10,090.5	4,577.0
		4	25.0	11.938	1,080,974	5,012.1	2,273.5
		5	30.0	9.956	172,453	666.9	302.5
	LDGT2 with VMT mix of 8.6%	1	15.0	21.780	59,240	244.9	111.1
		2	20.0	17.907	1,811,216	6,155.5	2,792.1
		3	25.0	14.409	2,176,263	5,951.4	2,699.5
		4	25.0	14.409	1,080,974	2,956.1	1,340.9
		5	30.0	12.033	172,453	393.8	178.6
	HDGV with VMT mix of 3.8%	1	15.0	29.310	59,240	145.6	66.0
		2	20.0	21.768	1,811,216	3,306.2	1,499.7
		3	25.0	17.080	2,176,263	3,117.1	1,413.9
		4	25.0	17.080	1,080,974	1,548.3	702.3
		5	30.0	14.160	172,453	204.8	92.9
	LDDV with VMT mix of 0.2%	1	15.0	2.039	59,240	0.5	0.2
		2	20.0	1.540	1,811,216	12.3	5.6
		3	25.0	1.217	2,176,263	11.7	5.3
		4	25.0	1.217	1,080,974	5.8	2.6
		5	30.0	1.007	172,453	0.8	0.3
	LDDT with VMT mix of 1.4%	1	15.0	1.967	59,240	3.6	1.6
		2	20.0	1.486	1,811,216	83.2	37.7
		3	25.0	1.174	2,176,263	78.9	35.8
		4	25.0	1.174	1,080,974	39.2	17.8
		5	30.0	0.971	172,453	5.2	2.3
	HDDV with VMT mix of 7.4%	1	15.0	14.491	59,240	140.2	63.6
		2	20.0	10.944	1,811,216	3,237.0	1,468.3
		3	25.0	8.650	2,176,263	3,074.1	1,394.4
		4	25.0	8.650	1,080,974	1,526.9	692.6
		5	30.0	7.155	172,453	201.5	91.4
	MC with VMT mix of 0.5%	1	15.0	23.728	59,240	15.5	7.0
		2	20.0	17.833	1,811,216	356.4	161.7
		3	25.0	14.220	2,176,263	341.5	154.9
		4	25.0	14.220	1,080,974	169.6	76.9
		5	30.0	11.606	172,453	22.1	10.0

5.6 Summary of CO Emissions from Onroad Mobile Sources

Table 5-5 summarizes the calculated CO emissions by vehicle class, area, and facility type. Total CO emissions from daily onroad mobile sources for the Maricopa County nonattainment area for the 1999 carbon monoxide season are estimated to be 490,261 kilograms per day or 1,080,822 pounds per day.

NOTE: Consistent with the 1990 base year inventory, only seasonal emissions were calculated for this portion of the inventory. In consultation with Mary Ann Warner-Selph, EPA Emissions Inventory Branch, it was determined that annual emission estimates were unnecessary for the 1990 base year inventory.

5.7 Quality Assurance Process

5.7.1 VMT Estimates

Normal quality assurance (QA) procedures, including extensive automated consistency checks, were used by ADOT in developing the 1999 HPMS data. A revised version of the 1999 data, incorporating improved traffic count data, was submitted to the Federal Highway Administration in April 2001. Additionally, as recommended in the Appendix B Level II Quality Review Checklist of the Quality Review Guidelines for 1990 Base Year Emission Inventories, July 1992, VMT per gallon of gasoline consumed was calculated as a check of the VMT estimates as described in Appendix 5-5.

5.7.2 Emission Factor Estimates

The QA process performed on the MOBILE5a analyses included accuracy, completeness, and reasonableness checks. For accuracy and completeness, a system was used that included a two-layer, independent reviewer set-up. All hard copy and computer-based data entries as well as all calculations procedures were checked independently for accuracy and completeness by two different reviewers. Any errors found were corrected and the changes were then rechecked by the reviewers.

The entire onroad mobile source portion of the 1999 periodic CO inventory was reviewed by MAG staff that did not directly participate in its development. All comments were addressed.

5.7.3 Quality Review of 1999 Periodic CO Emission Inventory

The draft onroad mobile source portion of the 1999 periodic carbon monoxide inventory was reviewed using published EPA quality review guidelines for base year emission inventories (EPA Document 450/4-91-022, September 1991). The procedural review (Levels I, II, and III) included checks for completeness, consistency, and the correct use of appropriate procedures.

Table 5–5. Daily Onroad Mobile Source CO Emissions (in kg/day) by Vehicle Class, Area Type and Facility Type – Winter

FACILITY		VEHICLE CLASS			
TYPE	**AREA TYPE**	**LDGV**	**LDGT1**	**LDGT2**	**HDGV**
INTERSTATE, FREEWAY, & EXPRESSWAY	1	3,538.1	1,420.2	841.8	576.7
	2	27,689.1	11,347.4	6,869.3	4,138.3
	3	19,757.6	8,119.8	4,928.4	2,894.0
	4	10,522.5	4,440.3	2,764.9	1,268.7
	5	3,729.4	1,586.3	995.0	428.8
	TOTAL	65,236.6	26,914.0	16,399.4	9,306.4
PRINCIPAL ARTERIAL & MINOR ARTERIAL	1	2,682.7	986.2	581.9	303.0
	2	48,767.2	17,991.2	10,618.5	5,521.2
	3	50,478.7	18,782.0	11,092.7	5,771.6
	4	21,884.9	8,241.3	4,872.1	2,566.1
	5	7,308.2	2,846.2	1,685.4	970.4
	TOTAL	131,121.7	48,847.0	28,850.6	15,132.4
COLLECTOR	1	1,565.3	568.9	335.5	176.4
	2	17,379.1	6,324.3	3,729.5	1,958.9
	3	7,669.9	2,804.8	1,654.4	864.8
	4	3,291.3	1,214.7	716.9	372.7
	5	4,218.0	1,554.6	917.4	477.2
	TOTAL	34,123.7	12,467.3	7,353.7	3,850.0
LOCAL	1	518.8	184.4	111.1	66.0
	2	13,246.0	4,733.7	2,792.1	1,499.7
	3	12,544.1	4,577.0	2,699.5	1,413.9
	4	6,230.8	2,273.5	1,340.9	702.3
	5	814.1	302.5	178.6	92.9
	TOTAL	33,353.9	12,071.2	7,122.3	3,774.9
GRAND TOTAL		**263,835.9**	**100,299.4**	**59,725.9**	**32,063.7**

TYPE	**AREA TYPE**	**LDDV**	**LDDT**	**HDDV**	**MC**	**TOTAL**
INTERSTATE, FREEWAY, & EXPRESSWAY	1	1.9	12.9	501.4	45.3	6,938.3
	2	13.0	87.9	3,421.8	420.2	53,986.9
	3	9.1	61.2	2,384.5	306.2	38,460.7
	4	3.8	25.5	991.8	196.0	20,213.4
	5	1.2	8.4	326.2	73.0	7,148.3
	TOTAL	29.0	195.8	7,625.7	1,040.6	126,747.6
PRINCIPAL ARTERIAL & MINOR ARTERIAL	1	1.1	7.7	298.9	33.1	4,894.6
	2	20.7	139.8	5,443.6	601.9	89,104.1
	3	21.6	145.7	5,675.6	620.7	92,588.5
	4	9.5	64.3	2,504.5	267.1	40,409.9
	5	3.5	23.5	913.5	89.6	13,840.4
	TOTAL	56.4	381.0	14,836.1	1,612.3	240,837.5
COLLECTOR	1	0.7	4.5	173.9	19.3	2,844.5
	2	7.3	49.6	1,930.9	214.4	31,594.2
	3	3.2	21.9	853.0	94.7	13,966.8
	4	1.4	9.4	367.5	40.6	6,014.6
	5	1.8	12.1	470.5	52.1	7,703.6
	TOTAL	14.4	97.5	3,795.8	421.1	62,123.6
LOCAL	1	0.2	1.6	63.6	7.0	952.9
	2	5.6	37.7	1,468.3	161.7	23,944.8
	3	5.3	35.8	1,394.4	154.9	22,825.0
	4	2.6	17.8	692.6	76.9	11,337.4
	5	0.3	2.3	91.4	10.0	1,492.3
	TOTAL	14.1	95.3	3,710.3	410.5	60,552.4
GRAND TOTAL		**114.0**	**769.5**	**29,968.0**	**3,484.6**	**490,261.1**

Additionally, the draft onroad mobile source portion of the 1999 periodic carbon monoxide inventory was compared with the onroad mobile source portions of the 1990, 1993, and 1996 base year and periodic inventories. The results are in the following table.

Year of Analysis	Onroad Emissions (kg/season day)	Onroad Emissions (pounds/season day)	Vehicle Miles Traveled (VMT/season day)
1990	732,745	1,615,399	45,877,773
1993	553,943	1,221,215	48,153,240
1996	508,259	1,120,500	53,091,273
1999	490,261	1,080,822	57,853,980

While the VMT increases over time, the modeled onroad CO emissions continue to decrease, principally because of a vehicle fleet with cleaner engine and emission control technologies, augmented by local controls such as the I/M program and cleaner gasoline. It is important to note that the base case emissions from the Serious Area CO Plan may not match those in the periodic inventories because of a different year modeled and different modeling domain size.

5.8 References for Section 5

Emission Inventory Requirements for Carbon Monoxide State Implementation Plans, EPA-450/4-91-011, March 1991.

MAG 1999 Serious Area Carbon Monoxide Plan for the Maricopa County Nonattainment Area, MAG, June 1999.

Maricopa Association of Governments Highway Performance Monitoring System Update, Lee Engineering, Inc., for MAG, January 1995.

1986 Phoenix Urbanized Area Travel Speed Study, Parsons Brinkerhoff Quade & Douglas, Inc., for MAG, October 1986.

1993 Study of Travel Speed and Delay in the MAG Region, Lee Engineering, Inc., for MAG, January 1995.

Procedures for Emission Inventory Preparation Volume IV: Mobile Sources, EPA-450/4-81-026d (Revised), 1992.

Quality Review Guidelines for 1990 Base Year Emission Inventories, EPA-454/R-92-007, July 1992.

User's Guide to MOBILE5 (Mobile Source Emission Factor Model), EPA-AA-AQAB-94-01, May 1994.

SECTION 6. QUALITY ASSURANCE

6.1 Introduction

This section describes the Quality Assurance (QA) procedures followed by the Maricopa County Environmental Services Department (MCESD) in the production of this 1999 periodic carbon monoxide emissions inventory for the Maricopa County nonattainment area. This section does not include the QA procedures taken when preparing the onroad mobile section of this inventory which are described in Section 5.7. When preparing stationary point, stationary area, and the aircraft and locomotive section of nonroad mobile sources these procedures were followed:

1. Reviewing the descriptive information included in each section to assure completeness, clarity and correctness;
2. Inspecting formulas, calculations and conversions to assure autonomy from errors and inconsistencies;
3. Evaluating data quality to assure the value of the inventory, both as a representative data set of the state of the air environment in the Maricopa County nonattainment area and as the reference point for future inventories; and
4. Assessing, where possible, the significance of the calculated quantities to assure reasonable accuracy and admissible precision.

The QA section of the Maricopa County emissions inventory follows the QA/QC plan in the Inventory Preparation Plan for the 1999 Periodic CO Emission Inventory (MCESD, 2001). This should show, without ambiguity, that Maricopa County's QA plan was implemented.

6.2 Purpose of an Emissions Inventory

Several objectives motivated the development of the emissions inventory:

1. To comply with the inventory requirements of the Federal Clean Air Act Amendments of 1990 and specifications of the U.S. Environmental Protection Agency;
2. To provide a baseline against which to evaluate trends and successes in CO emission reduction efforts;
3. To support development of air quality models and planning activities; and,
4. To underscore particular concerns and to direct attention to areas where significant air quality improvement is achievable.

To assure production of an emissions inventory that is complete, accurate, and in compliance with requirements set forth in the EPA document Guidance for the Preparation of Quality Assurance Plans for Ozone / Carbon Monoxide SIP Emission Inventories, four operational steps were followed: 1) planning; (2) collecting data, distinguishing point sources from area sources and establishing data collection procedures appropriate for each type of source considered; (3) analyzing data and developing emission estimates for each type of source; and (4) summarizing and reporting data.

6.3 Quality Assurance Staff

The Quality Assurance program staff is comprised of:

Renee Kongshaug, MCESD	Internal QA Coordinator
Bob Downing, MCESD	Point sources
Ruey-in Chiou, MAG	Highway vehicle emissions
Randy Sedlacek, ADEQ	Oversight and external QA

6.4 Implementation

Quality assurance checks occurred on receipt of data (missing and/or questionable data), on completion of calculations (computational methods, accuracy, reasonableness), on formatting of data (transcription errors, reasonableness either on a facility or categorical basis), and on inventory assembly (completeness, reasonableness). The QA point and area source coordinator reviewed the Inventory Preparation Plan (IPP) (MCESD, 2001), checked calculations, identified errors, performed completeness, reasonableness and accuracy checks.

Data collection procedures followed EPA guidance to assure inclusion of all source categories in the inventory. A listing of point sources was assembled from the existing point source inventory and the county's inventory database, EMS (described in Section 2). Any questionable data were verified by telephone, fax or e-mail. Examples of data collection and data verification procedures are included in Appendix 2–1.

Data quality was evaluated using several approaches. Data were cross-checked where multiple sources were available, and activity-level based data were given preference. All calculations were reviewed for accuracy and method consistency, and those calculations done in spreadsheets were recalculated with a calculator or by hand as an error checking procedure. Examples of these recalculations are included in Appendix 2–1.

MCESD made necessary corrections to the inventory as errors were revealed through its own QA procedures and as recommended by other agencies. As a final check before the inventory was considered complete, MCESD staff completed the electronic inventory review checklists (see Appendix 6–1). These checklists cover Level I and Level II checks (EPA, August 1992). During this final review, staff discovered only minor areas that needed attention. Data handling and reporting essentially is a reflection of EPA guidance documents and data reporting requirements. External comments made while reviewing the draft document are included in Appendix 6-2.

6.5 Review and Evaluation of Inventory Elements

6.5.1 General Statement

The general plan of the quality assurance program is described in the IPP (MCESD, 2001). Formal training sessions for inventory personnel were provided by EPA training workshops, as available. Informal training sessions for MCESD inventory staff were held as further EPA guidance became available. Topics covered in these sessions included:

1. Contents of existing and new EPA emissions inventory-related guidance or policy.
2. New or updated data sources or procedures for determining emissions estimates.
3. National Emission Inventory/ NIF training.
4. MCESD policy and standard operating procedures.

New personnel received briefings from their respective supervisors. However, most of their training regarding the details of their duties was received while on the job. Training materials (e.g., books and manuals) were available to familiarize new personnel with inventory work.

6.5.2 Point Sources

Two environmental planners checked inventory accuracy, reasonableness and assured that all point sources had been identified and that the methodology applied to calculate emissions was appropriate and that the calculations were correct. Other reasonableness checks were conducted by recalculating emissions by using methods other than those used to make the initial emissions calculations and then by comparing results. A quality assurance check of EMS was made on all SCC codes for determining the appropriate categories for facility's emission units. Quality analysis (QA) was conducted by checking all emissions reports submitted to MCESD for the year 1999 for missing and questionable data and by checking the accuracy and reasonableness of all emissions calculations made for such reports. Notes concerning follow-up calls and corrections to calculations were documented on each 1999 annual emissions report.

Data entry for the NEI will be verified against the original hardcopy files for completeness and reasonableness. Since some data sources are more reliable than others, it is important that the reliability of the data be taken into account. For this reason, MCESD assessed all data against the capabilities and biases (if any, and if known) of the organization supplying the data, the techniques used to collect the data (if known), and the purpose for which the data were compiled. This assessment allowed MCESD to understand the limitation of the data and to choose the best data for developing emissions estimates.

Inconsistencies were located in the data presentation (i.e. significant figures) and were corrected. General corrections to format were made including references to specific appendices. Text was added to clarify how peak CO season daily emissions were calculated. There had been some facility name discrepancies that were corrected. Text was added to clarify that the power plant peak CO season daily emission estimates came from data provided by each source for a worst case day in 1999. Text was also added to clarify that all point sources were re-inventoried and to outline the criteria for a facility to be included as a point source.

6.5.3 Area Sources

In the creation of the area source emissions inventory, two environmental planners checked data and calculations for accuracy, completeness and reasonableness and then reviewed the methodology, and rechecked data for completeness, reasonableness, and a sample of the calculations. All miscalculations were corrected and then rechecked. All issues were discussed. A number of format changes were made along with adding more text, a new category and some changes in methodology.

The external reviewer checked accuracy in methodology based on the Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Volume I (EPA, May, 1991) document. It was verified that all source categories listed in the Emission Inventory Requirements for Carbon Monoxide State Implementation Plans (EPA, March 1991) document were included. Reasonableness checks were performed by recalculating emissions using alternate methodologies and by comparing results and/or analyzing totals and inputs to determine reasonableness.

Significant figures inconsistencies were located in the data presentation and were corrected. Example calculations were added to each section for clarity. Conversations with the natural gas suppliers led to corrections to the document and calculations. General corrections to format were made including references to specific appendices.

Stationary Area Sources - Fuel Combustion

Input data in this source category are of high quality and verifiable by independent calculation. Within Maricopa County, natural gas is the principal fuel burned. Quantities of natural gas distributed to sub-categories (e.g. Electric Utilities, Industrial, etc.) were obtained from three distribution sources and were subtracted from point source usage (data obtained from EMS, Maricopa County's database) to estimate area source usage. These calculations were rechecked and a few errors from inconsistent emission factors or coding discrepancies were corrected.

Stationary Area Sources - Other Combustion

This category combined several miscellaneous sources, many with roughly estimated emission factors. Qualitative dimensional assumptions and gross estimates of the quantities of materials burned were made. However, these reported quantities are so large, and their calculated contributions to the CO emission inventory of area sources are so significant, that they may overwhelm the more substantiated emission values of other sources.

This is especially true in the case of wood burning in fireplaces and woodstoves. This sub-category accounts for 87% of the reported 1999 CO emissions contributed by "Other Combustion" sources (2,830.2 tons/year of a total 3,241.2 tons/year), yet the reported emission level is based on questionable assumptions of fireplace population and of the extent of the wood burning season.

Similar reservations exist for the sub-category "Structure and Motor Vehicle Fires"; however, the total reported emissions of this group are a much less significant contribution to the inventory.

6.5.4 Nonroad Mobile Sources

The quality assurance process for 1999 aircraft and locomotive CO emissions engaged the efforts of two environmental planners validating input data and performing calculations and reasonableness checks on each other's work. This was followed by an external reviewer's check of the section. The QA coordinator checked for accuracy, reasonableness, completeness of emission sources and logical methodology based on chapters five and six of the EPA Emission Inventory Preparation Document (EPA, 1992). Several formatting inconsistencies were found and corrected. Additional reference material was requisite to document sources of information, and therefore included. An error in aircraft operations was discovered, and the correction created a series of amendments to the document and calculations. All issues were addressed and corrected.

General corrections to format were made including references to specific appendices. References were added to indicate the source of aircraft activity information for each airport.

6.5.5 Onroad Mobile Sources

See Section 5.7 of this document for the quality assurance narrative regarding this category.

6.6 Summary Statement

The accuracy of this inventory is a measure of the quality of our knowledge of the day-to-day, seasonal and annual statistics of emissions sources in the Maricopa County nonattainment area. Although effort was made to ensure that the data expressed in this inventory accurately represents the emissions in the nonattainment area in 1999, all components of the inventory, taken together, are subject to continued improvement.

The degree to which we are able to improve the quantity and accuracy of source data will determine the quality and reliability of future inventories. Efforts will be focused on obtaining valid and reliable information as well as improving emission calculation methods for future inventories.

6.7 References for Section 6

Maricopa County Environmental Services Department. Inventory Preparation Plan: Carbon Monoxide. April 2001.

U. S. Environmental Protection Agency. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Vol. I. EPA-450/4-91-016. May 1991.

U. S. Environmental Protection Agency. Emission Inventory Requirements for Carbon Monoxide State Implementation Plans. EPA-450/4-91-011. March 1991.

U. S. Environmental Protection Agency. Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. EPA-450/4-81-026d (Revised), Chapter 5. Office of Mobile Sources. Ann Arbor, MI. 1992.

U.S. Environmental Protection Agency. Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources. EPA-450/4-81-026d (Revised), Chapter 6. Office of Mobile Sources, Ann Arbor, MI. 1992.

U. S. Environmental Protection Agency. Procedures for the Preparation of Emission Inventories for Carbon Monoxide and Precursors of Ozone, Vol. III: Emission Inventory Requirements for Photochemical Air Quality Simulation Models, EPA-450/4-91-014. May, 1991.

U. S. Environmental Protection Agency. Guidance for the Preparation of Quality Assurance Plans for Ozone/Carbon Monoxide SIP Emission Inventories. EPA-450/4-88-023.

U. S. Environmental Protection Agency. Quality Review Guidelines for 1990 Base Year Emissions Inventories, EPA-450/4-91-022. August 1992.

U.S. Environmental Protection Agency. EIIP Volume VI: Chapter 3 General QA/QC Methods, June 1997.